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NAVAL POSTGRADUATE SCHOOL

Monterey, California

OCEANOGRAPHIC MEASUREMENTS NEAR
THE ARCTIC ICE MARGINS

by

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NAVAL POSTGRADUATE SCHOOL
Monterey, California

Rear Admiral Mason B. Freeman
Superintendent

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Provost

ABSTRACT:

Temperature and salinity measurements were made in and near the ice in the Chukchi and Beaufort Seas with a continuously profiling instrument in August of 1971 and 1972 as a part of the MIZPAC Program. Warm water of Bering Sea origin was found south of the ice in all of the area surveyed, layered sharply on top of cold water. Complex temperature and sound-velocity profiles were found near the Alaskan Coast north of the ice margin, diminishing in intensity toward the interior of the ice pack but still noticeable 30 miles inside the ice boundary. West of the coastal zone, to 167° W, the phenomena were much milder and more quickly damped by the ice. The coastal current was observed to turn, perhaps branch, and flow along the Beaufort Sea slope, below the surface at a depth of 25-50 m, to a longitude of 152° W. Other information indicates that it maintains its identity for at least another 100 miles eastward.

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TABLE OF CONTENTS

LIST OF FIGURES

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I. INTRODUCTION

This report describes the results of two cruises in which the meso-scale structure in the water column was measured near the ice margins in the Chukchi and Beaufort Seas. The cruises were part of larger operations directed by the Arctic Submarine Laboratory, Naval Undersea Center, San Diego, and are named MIZPAC 71 and MIZPAC 72. The cruises took place in July and August of 1971 and 1972. The basic measuring tool was the Bissett-Berman salinity-temperature-depth recorder. The data were reduced by tracing the recorder curves with a Calma Digitizer, correcting, and computing sound velocity and sigma-t on the Naval Postgraduate School IBM 360/67 computer. Computer-generated plots, listings and magnetic tape records were produced.

The investigation had its origin in reports of severe deterioration of sonar propagation near the ice margins. The effects were presumably due to the existence of complex sound-velocity profiles and rapid changes in propagation conditions with distance. The objectives of the investigation were to describe the complex sound-velocity profiles and discover the oceanographic processes which cause and modify them.

A secondary responsibility was to supply oceanographic data for other programs going on at the same time in the area.

The two cruises differed somewhat in nature. The first was strongly committed to tending two drifting ice floe stations. This had a strong influence on the area covered and limited the free choice of station positions for the oceanographic purposes. Nevertheless, interesting results were obtained. This cruise also was faced by considerably greater equipment problems than was the second.

The second cruise, although again committed to some other objectives, was able to make a number of closely spaced crossing of the ice margin and also do some exploration in the open water to the south. Equipment problems were few and data was obtained from essentially all of the 114 stations occupied.

In the first cruise the ice margin was diffuse and generally located in its normal position. In contrast, the ice margin in the second cruise was relatively compact and was much farther to the north.

In the report which follows, the results of the two cruises are described separately. The conclusions in the two separate sections are sequential, the second set benefiting from the first set. The overall conclusions from the two sets of data are then given in Section IV.

II. MIZPAC 71

A. INTRODUCTION

In 1971 the research vehicle was the icebreaker USCGS NORTHWIND, the time was 30 July to 20 August and the area extended from the northeastern Chukchi Sea to the southwestern Beaufort Sea, as shown in Figure 1. The deepest penetration into the ice was about 30 miles. The icebreaker had other commitments, particularly the shepherding of two drifting ice stations and some search and rescue work. The latter led to the long excursion to the southwest along the coast and resulted in a better understanding of the coastal current than would have resulted had the uninterrupted plan been followed. The manned ice stations required fairly close shepherding by the ice breaker so they could be found and rescued in case of emergency. Also, because the ice stations drifted rapidly into the coastal current and then around Pt. Barrow into the Beaufort Sea, the area of coverage was shifted eastward from what had been planned.

On this cruise the rapid changes in water structure near the ice had not been recognized; therefore the closely spaced crossings of the ice margin which were included in the 1972 cruise were not planned specifically. There were opportunities for time series, which were done in 1971 but not in 1972.

B. TECHNIQUES

The Bissett-Berman Model 9006 STD was kindly loaned by the U.S. Naval Oceanographic Office. It was termed an "Arctic Model" because the temperature scale extended to $-2^{o}C$. However, the lower end of the salinity scale extended to only 30o/oo and the instrument would produce neither temperature nor salinity outputs at lower salinities. This left the instrument incapable of sampling the upper 10-15 meters of the water column for roughly 3/4 of the stations. Therefore, the STD was supplemented by a hand-lowered Beckman RS5 conductivity-temperature meter which provided discrete readings. This meter is hereafter called the RS5.

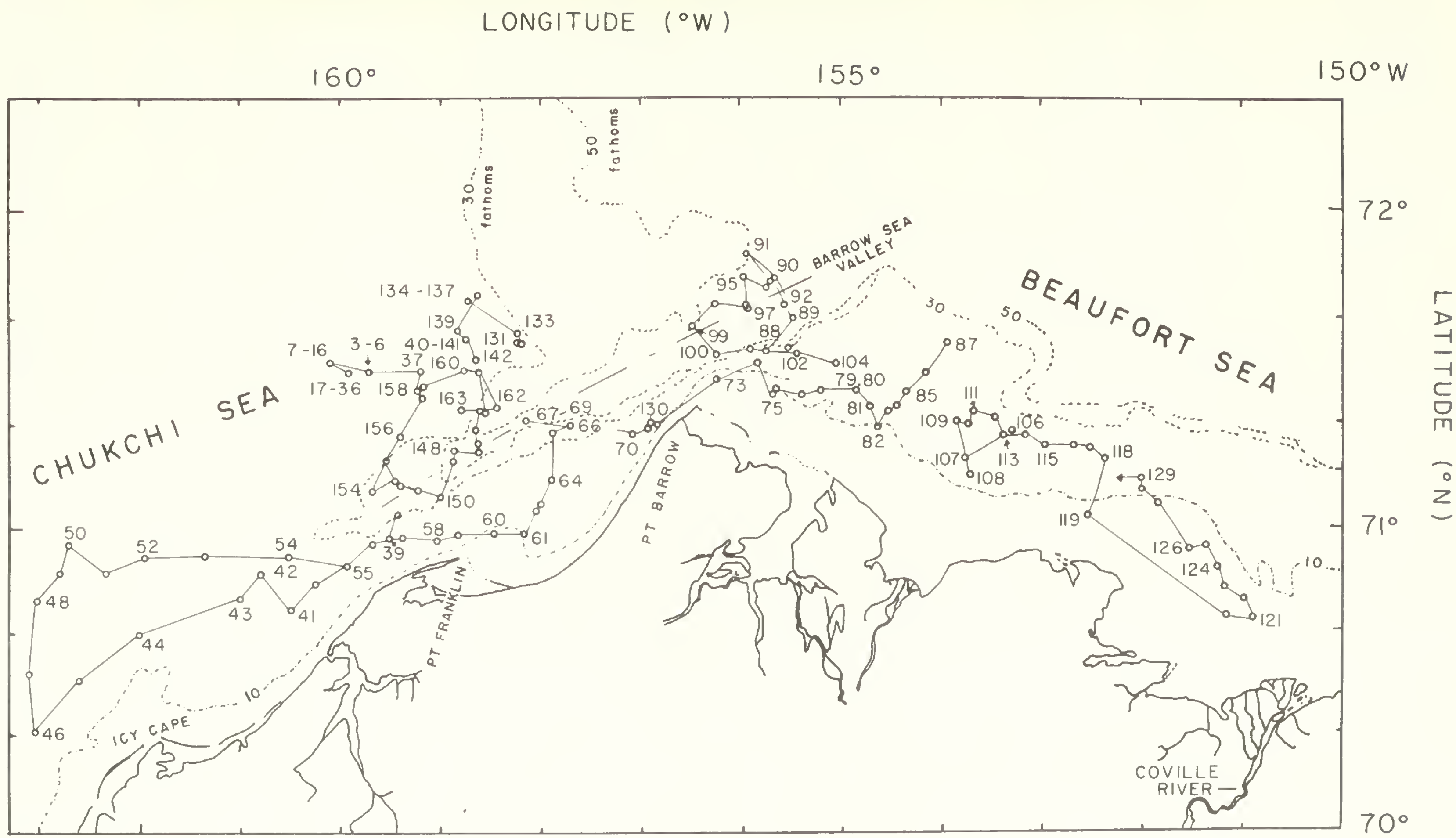

Figure 1. MIZPAC 71 station positions.

Late in the cruise, between Station 105 and the last one at Station 163, a calibrated shunt was introduced into the STD conductivity cell. This brought most of the low salinities on scale. These stations were then done in two lowerings which were labeled S and D (shallow and deep) during data reduction.

The STD has a slow-acting analog conversion circuit to convert electrical conductivity to salinity. Although the manufacturer quotes a response time of 0.3 seconds for this circuit, it was measured experimentally as 2.0 seconds. This slow response caused troubles, as will be shown below. The marginal ice zone is full of sharp temperature gradients, some as great as $7^{O}C$ per meter. The winch lowering speed was basically 0.55-0.65 m/sec. Up to Station 40 the lowering was stopped at fixed depth intervals, but thereafter the STD was lowered and raised continuously at the above speed.

The salinity error due to lag in the compensating thermometer may be roughly estimated in the following way. When the instrument passes through a temperature gradient, the error in temperature will not be greater than that resulting from a temperature ramp which continues for several time constants of the thermometer. The first-order thermometer response equation is easily solved for this case and the error is found equal to the product of the time constant and the time rate of change of temperature. Suppose one examines the extremes, assumes $3^{O}/m$ as a more common temperature gradient than $7^{O}/m$ and assumes a winch speed of 0.6 m/sec. Then the time rate of change is $1.8^{O}/sec$ and the temperature lag is 3.6^{O}. This corresponds to 3.6 o/oo salinity error. Actually, such sharp gradients do not continue for several time constants and the error computed above is likely to be too large by a factor of 1.5 to 2.0. Therefore, one expects spurious salinity spikes of a magnitude approximating one to two parts per thousand in the sharper thermoclines. Elsewhere the errors are much more moderate.

The error resulting from a temperature ramp decays to zero when the ramp ends. Therefore, an STD passing through a step-like temperature gradient creates an anomalous spike in the salinity, pointing in the same direction as the temperature change. If the temperature profile contains a one-sided oscillation, the salinity anomaly will be S-shaped.

Although these salinity transients made a messy record, they eventually led to little difficulty; we merely ignored them in tracing the records and little serious error seems to have resulted.

Scale changing on the STD proved to be a chore because the gradients were so large that one could go through two scale changes in a few seconds of lowering time. There was no low-sensitivity scale

and the individual scales had widths of 2 ppt starting at 30 o/oo and increasing 1.5 o/oo per scale step through six scales. Beginning at Station 53 the potentiometer of the potentiometer recorder was shunted with a precision resistor to make it span 4 o/oo on each scale. Thereafter there seldom was need to use any but Scale 1 (30-40 o/oo), except when the shunt on the conductivity cell was used. The temperature range -2° to $+8^{\circ}$ C was used exclusively.

The instrument was subjected to an unusual amount of electrical interference from the search radar or some of the equipment involved in helicopter launches. Useful data could not be obtained at a number of stations because of this factor. At these times the instrument usually was replaced by the Beckman conductivity-temperature meter.

The effect of the shunt was determined by finding the apparent conductance change it produced in the STD in air. Tables of seawater conductivity were then used to construct a table of equivalent salinity change as a function of salinity and temperature. Over the limited temperature range involved, this turns out to be a simple second degree equation. A controlled calibration in seawater was not possible so a check of the equation was attempted by comparing salinities where the shallow and deep lowerings overlapped. This did not work well because the depth of overlap was in a region of sharp temperature and salinity gradients and the depth errors of the STD created substantial uncertainties. There was a rapid change with time in this depth zone. For these reasons it has not been possible to certify that the computed salinities are any more accurate than $\pm$ 0.3 o/oo.

Similar problems are involved in the Beckman conductivity-temperature meter. Its results were compared with the STD at points of overlap where conditions appeared fairly stable. The mean temperature error was -0.29° C and the salinity error -0.41 o/oo. The standard deviations of the mean were 0.04° and 0.06 o/oo respectively. The mean corrections were applied but considerable uncertainty remains, particularly because it could not be determined if there were non-random deviations.

It should be noted that temporal and spatial variations in water properties are so great in the region in and above the thermocline, where the shunt and the RS5 were used, that errors of the magnitude cited above are unimportant.

The STD itself was continually standardized by means of a Nansen bottle, just above the instrument, which was tripped at the greatest depth of lowering. The salinity error averaged 0.09 o/oo with a standard deviation of the mean σ_M, of 0.01 o/oo. The temperature error

was -0.07° and σ_M was 0.007°. Corrections were made for the mean errors; accuracies for the unshunted STD comparable to $\pm 2\sigma_M$ therefore may be expected in those parts of the water column in which the temperature gradients were small.

This instrument had pressure-sensitive recording paper which traces a record which is difficult to read and makes it impossible to differentiate the salinity and temperature traces by means of ink color. The depth scale was approximately 30 m/in, which results in too condensed a record for shallow water, especially in the Arctic. These factors and the requirement to derive sound velocity led to the decision to trace the STD records with a Calma digitizer and carry out conversions and plotting with a computer.

C. REDUCTION OF DATA

A relatively complicated computer program, MIZ1, was used to convert Calma digitizer tapes to corrected salinities and temperatures. The program also computed sound velocity and sigma-t, patched in RS5 data at the surface, filled small gaps between curve segments (where scale changes occurred) and classified the results on 0.3-meter depth increments for output in a continuous sequence. Wilson's equation was used for sound velocity and Knudsen's for sigma-t. Missing data were replaced with zeros, except for the temperatures, which were set to -3°. The outputs were printed and punched on cards.

After editing the cards for minor errors and arranging the stations in sequence, the cards were used as inputs to programs which produced various plots and finished output on the printer and on magnetic tape. Heading data were introduced on cards before the finished outputs were produced. Missing data were excluded from the plots and were replaced by blanks in the printed data; however, they still appear as zeros and -3's on the tape.

Approximately ten other computer programs were written to do various housekeeping jobs, produce T-S plots and nested temperature plots, convert conductivities to salinities and produce compatible output cards from Beckman conductivity-meter data.

The plots originally were produced in approximately 10 by 12-inch size except for some nested temperature plots which were longer. There was at first no capability for putting the shallow and deep portions of a multiple lowering on the same plot except for the output of the Beckman meter which routinely was inserted by MIZ1. However, there were some Beckman lowerings which had large overlaps and were treated separately. Therefore, 183 station plots were produced from the 163

stations, about 35 of them in two parts. About 15 stations are missing entirely because of electrical interference, equipment problems, unreadable records, and uncorrectable errors made on the digitizer.

In the 1972 data most of the stations had two lowerings. The sheer volume of plotted data dictated that both lowerings be put on one plot and that the plot be of a size which could be reproduced without reduction. These results were so much more desirable than the first that all of the 1971 data were replotted in this way.

Figure 2 shows a typical station listing, the output of MIZPRT. The coding for the heading is detailed in Appendix I together with information on the magnetic tape format.

D. RESULTS

Complete data sets (print-outs, plots, and tape) have been submitted to the Arctic Submarine Laboratory. This report presents only such data as is needed to describe and explain the observed phenomena. A complete list of heading data for both 1971 and 1972 is given in Appendix II.

In the following presentation, the oceanography of the area will be presented followed by and intertwined with the nature and distribution of anomalous temperature and sound velocity structures and their causes.

The oceanography of the coastal region in the Eastern Chukchi and southwestern Beaufort Seas is dominated by a warm current which has its origin in Bering Strait. This current flows northeastward close to the Alaskan Coast, rounds Pt. Barrow and flows eastward into the Beaufort Sea. Although the southern portion of the current has been described previously (e.g., English, 1963) and its continuation to the northeast inferred, this is the first time that it has been well described north of about 70^{o}-30' N and the first time that a survey has followed its turn to the east. Fortuitously, Hufford (1973) working independently at the same time, followed it from our most easterly point near 152^{o} W to about 147^{o}W.

The course of the current and its structure may be seen in a series of diagrams, Figures 3 to 11. Figure 3 shows the location of six vertical sections of temperature. Figure 4 shows a plan view of the maximum temperature in the water column. This type of presentation is necessary because the warm water does not stay at a fixed depth; it starts at the surface at the southernmost end of the cruise and descends ultimately to the depths of 30-50 meters or deeper beyond the break of the Beaufort Sea Shelf. Figure 5 shows the ice distribution as it was found at the time stations were occupied. Figures 6a and 6b show temperatures in the

OCEANOGRAPHIC DATA MIZPAC 71, STATION 139S

NATION 31 SHIP NW LAT 71-38. N LONG 158-50.5 W MSQ 268 DATE 08/18/71 GCT 18.4
STA.NO. 139S WATER DPTH DP LWRG STARTS AT 13 M NO.OBS. 45 CODE 3 ICE 6
WAVE: DIR HT 0 PER WIND: DIR , SPD BAR DRY BULB . WET BULB .
WETHR CLOUD TYP , AMT

DEPTH METERS	TEMP. DEG.C.	SALNTY. PPT.	SND.VEL. M/SEC	SIGMA-T	DEPTH METERS	TEMP. DEG.C.	SALNTY. PPT	SND.VEL. M/SEC	SIGMA-T
0.0	-0.57	24.57	1432.07	19.744	7.2	-0.75	27.62	1435.54	22.205
0.3	-0.58	25.10	1432.75	20.174	7.6	-0.77	27.85	1435.77	22.393
0.6	-0.70	25.18	1432.28	20.243	7.9	-0.77	28.22	1436.27	22.686
0.9	-0.72	25.34	1432.39	20.365	8.2	-0.77	28.24	1436.31	22.703
1.2	-0.73	25.68	1432.81	20.640	8.5	-0.75	28.26	1436.44	22.719
1.5	-0.73	26.10	1433.40	20.983	8.8	-0.70	28.69	1437.24	23.066
1.9	-0.75	26.17	1433.45	21.034	9.1	-0.67	28.85	1437.63	23.200
2.2	-0.78	26.27	1433.45	21.122	9.5	-0.66	28.89	1437.72	23.224
2.5	-0.80	26.29	1433.38	21.136	9.8	-0.65	29.38	1438.47	23.624
2.8	-0.81	26.33	1433.40	21.171	10.1	-0.65	29.52	1438.67	23.739
3.1	-0.82	26.79	1433.98	21.542	10.4	-0.68	29.64	1438.69	23.834
3.4	-0.82	27.00	1434.27	21.706	10.7	-0.70	30.28	1439.48	24.349
3.8	-0.79	27.07	1434.52	21.760	11.0	-0.65	30.44	1439.96	24.479
4.1	-0.76	27.15	1434.79	21.826	11.4	-0.50	30.47	1440.69	24.496
4.4	-0.75	27.24	1434.96	21.897	11.7	-0.47	30.47	1440.85	24.499
4.7	-0.73	27.24	1435.02	21.896	12.0	-0.44	30.48	1441.01	24.503
5.0	-0.75	27.23	1434.97	21.895	12.3	-0.44	30.48	1441.01	24.503
5.3	-0.76	27.23	1434.92	21.894	12.6	-0.46	30.54	1441.01	24.553
5.7	-0.76	27.27	1434.98	21.924	12.9	-0.64	30.56	1440.20	24.572
6.0	-0.75	27.37	1435.17	22.004	13.3	-0.77	30.64	1439.72	24.640
6.3	-0.69	27.50	1435.61	22.109	13.6	-0.80	30.92	1439.97	24.867
6.6	-0.68	27.53	1435.71	22.134	13.9	-0.85	31.00	1439.85	24.937
6.9	-0.68	27.59	1435.79	22.183					

Figure 2. Typical station listing, 1971.

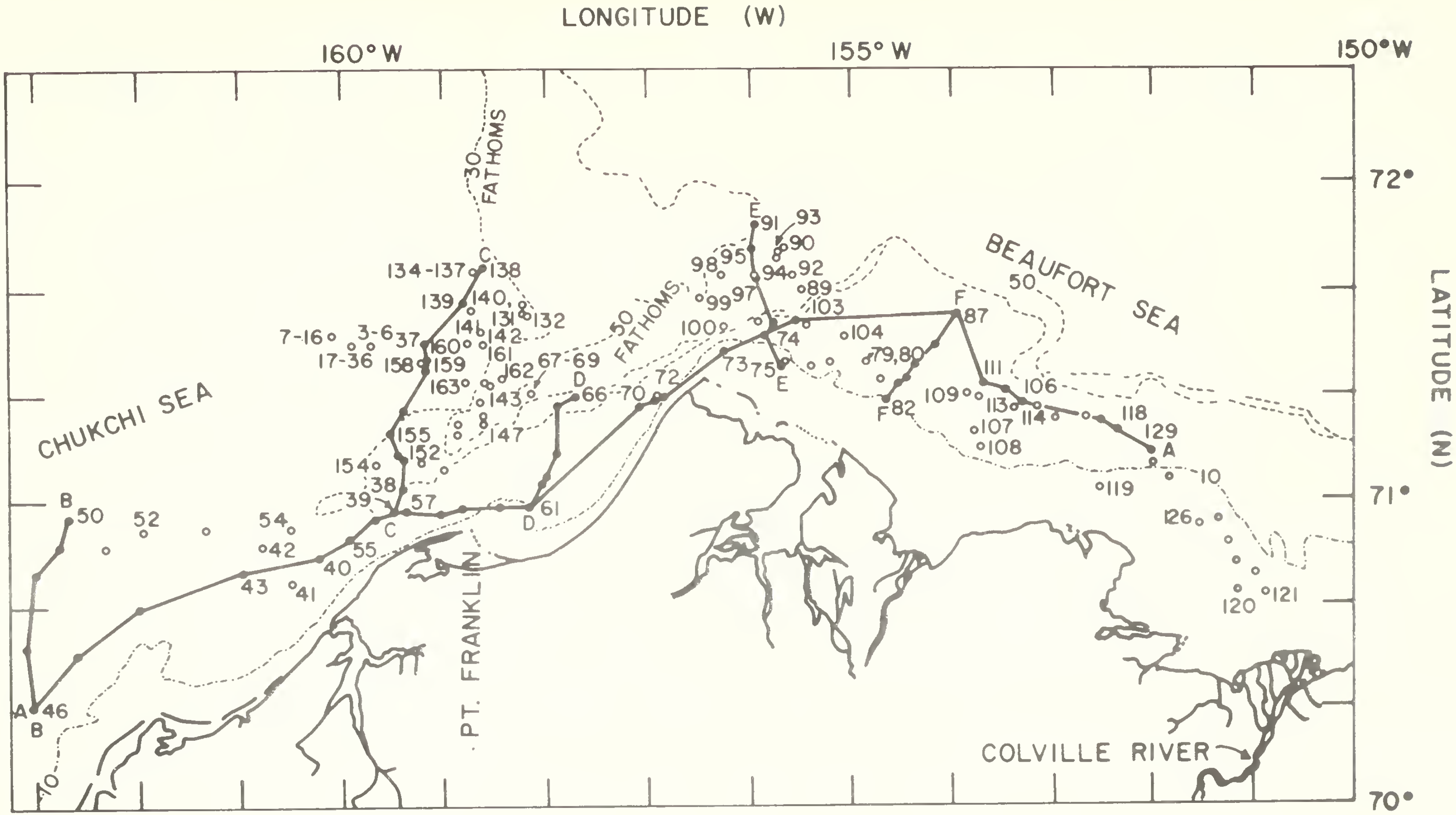

Figure 3. Locations of vertical temperature sections.

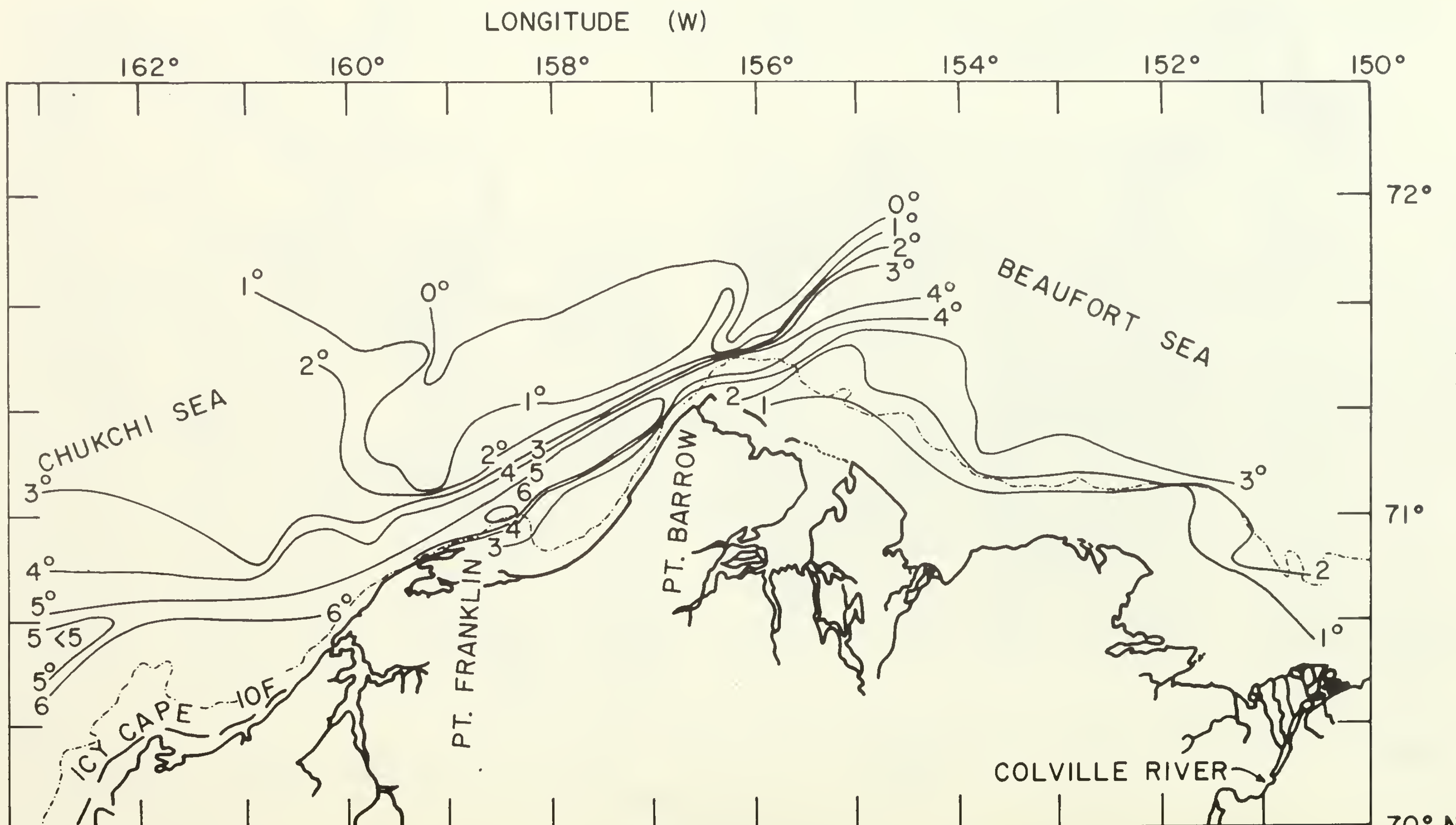

Figure 4. Plan view of maximum temperature in the water column. Temperature in °C.

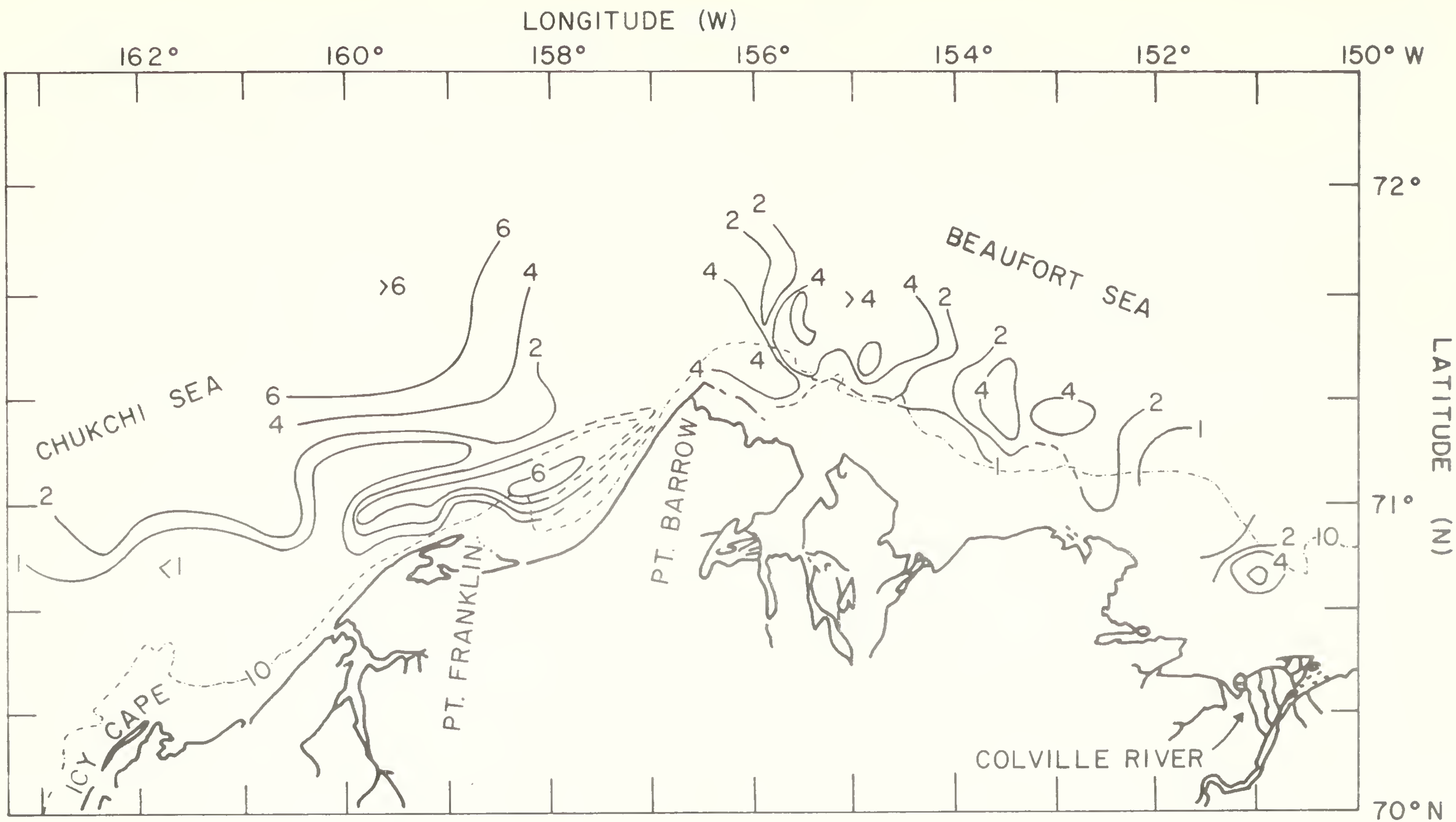

Figure 5. Ice concentrations in oktas (eights) from observations on station, 1971.

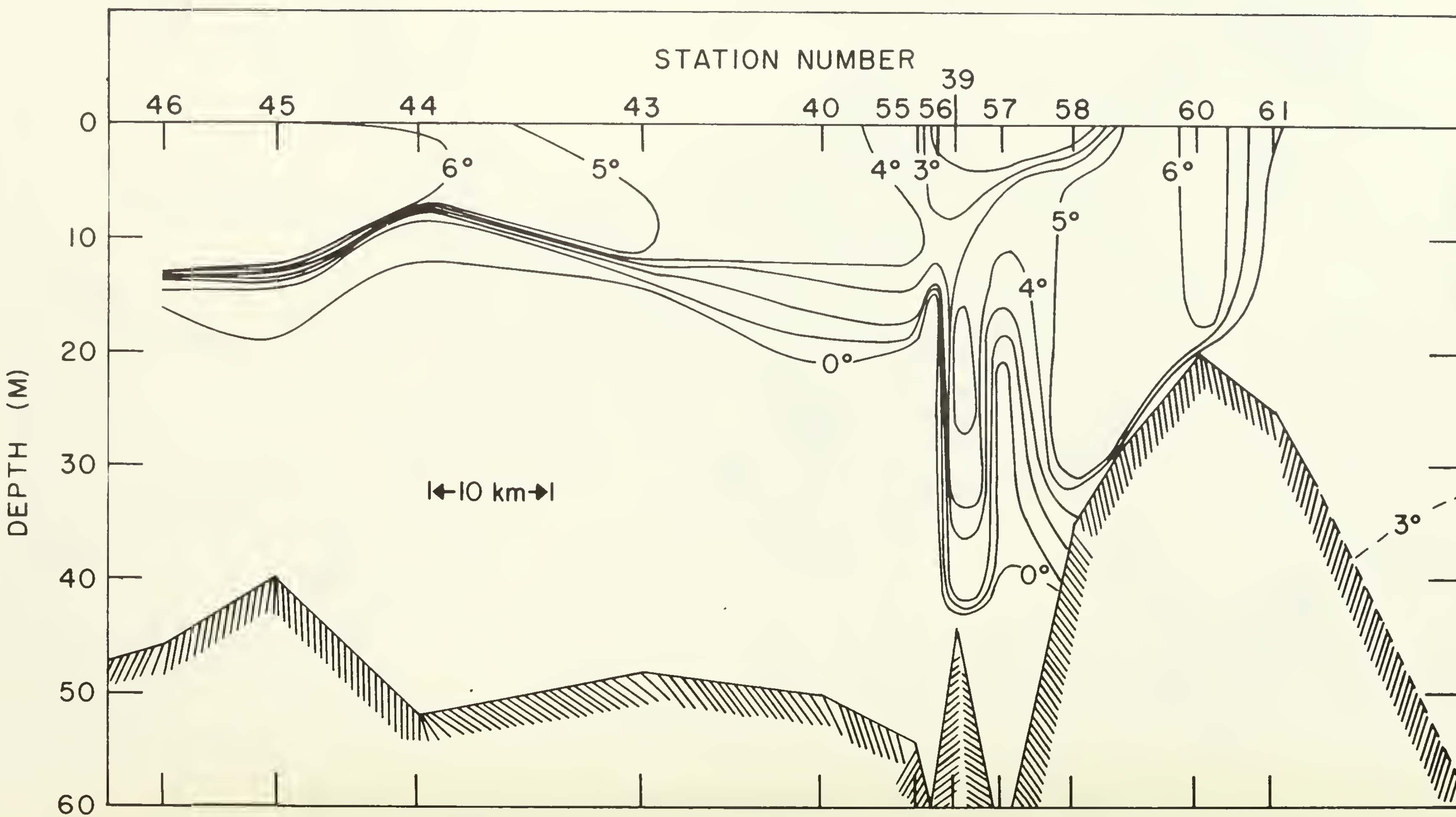

Figure 6a. Temperature in the longitudinal section A - A.

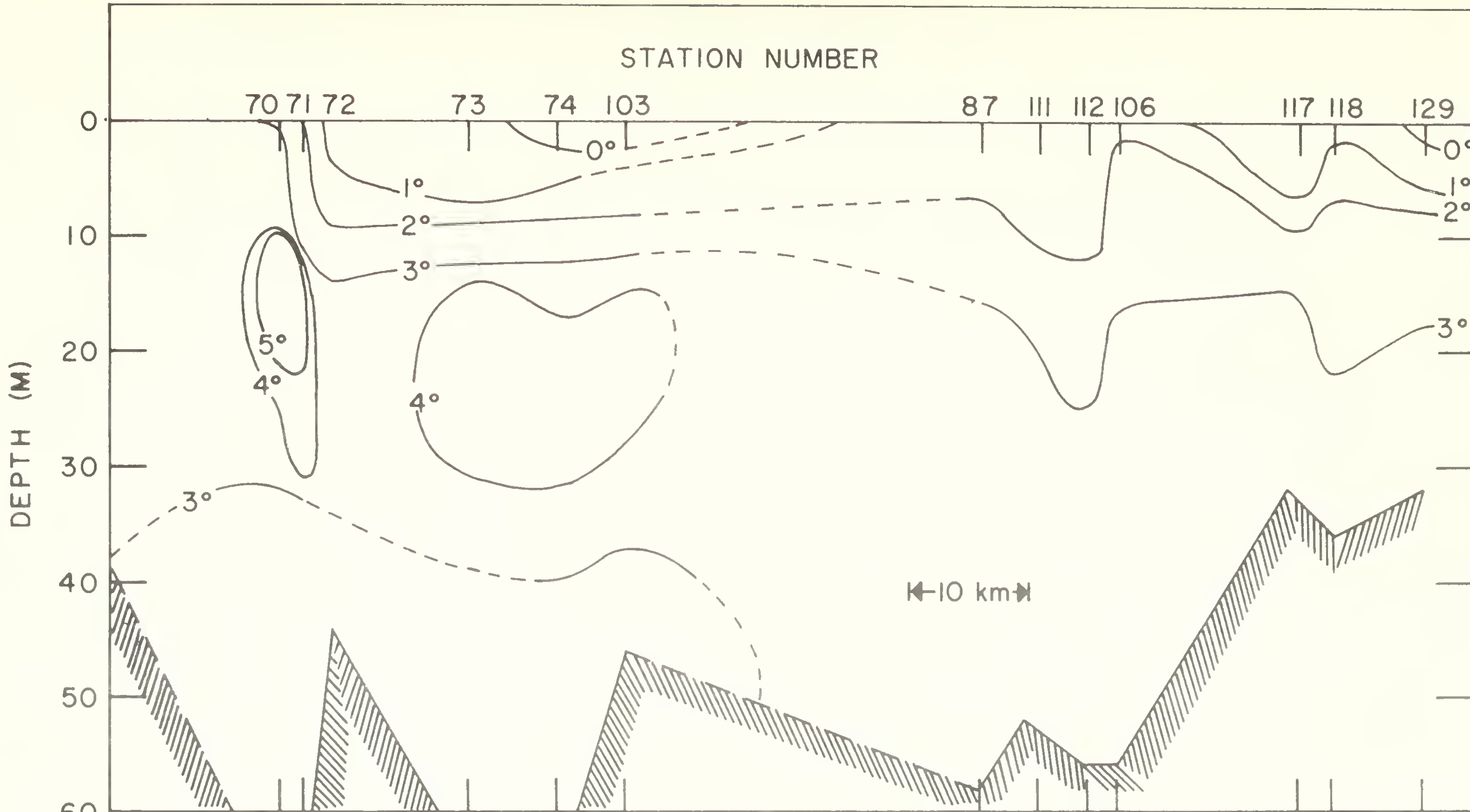

Figure 6b. . Temperature in the longitudinal section A - A.

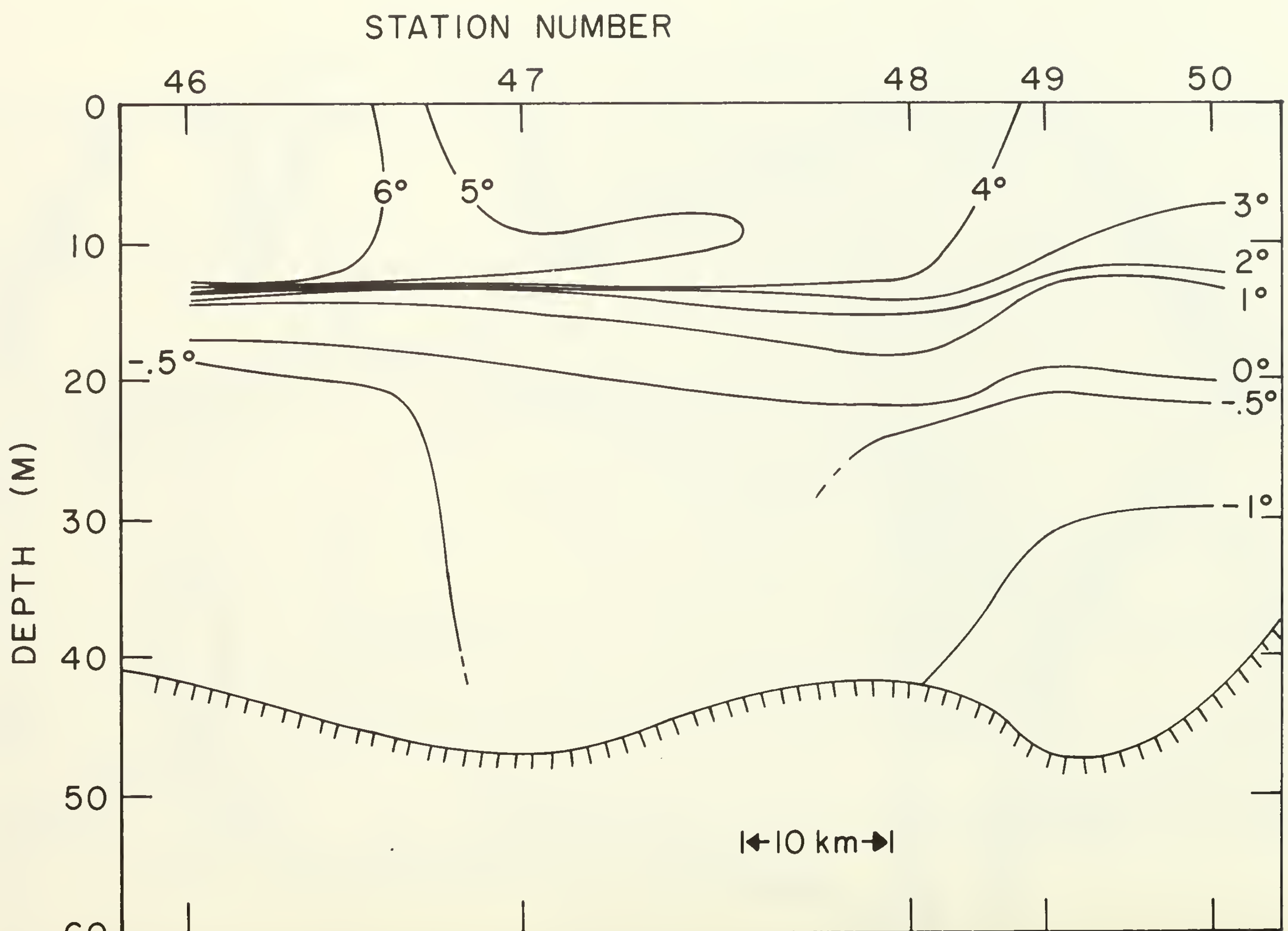

Figure 7. Temperatures in the section B - B.

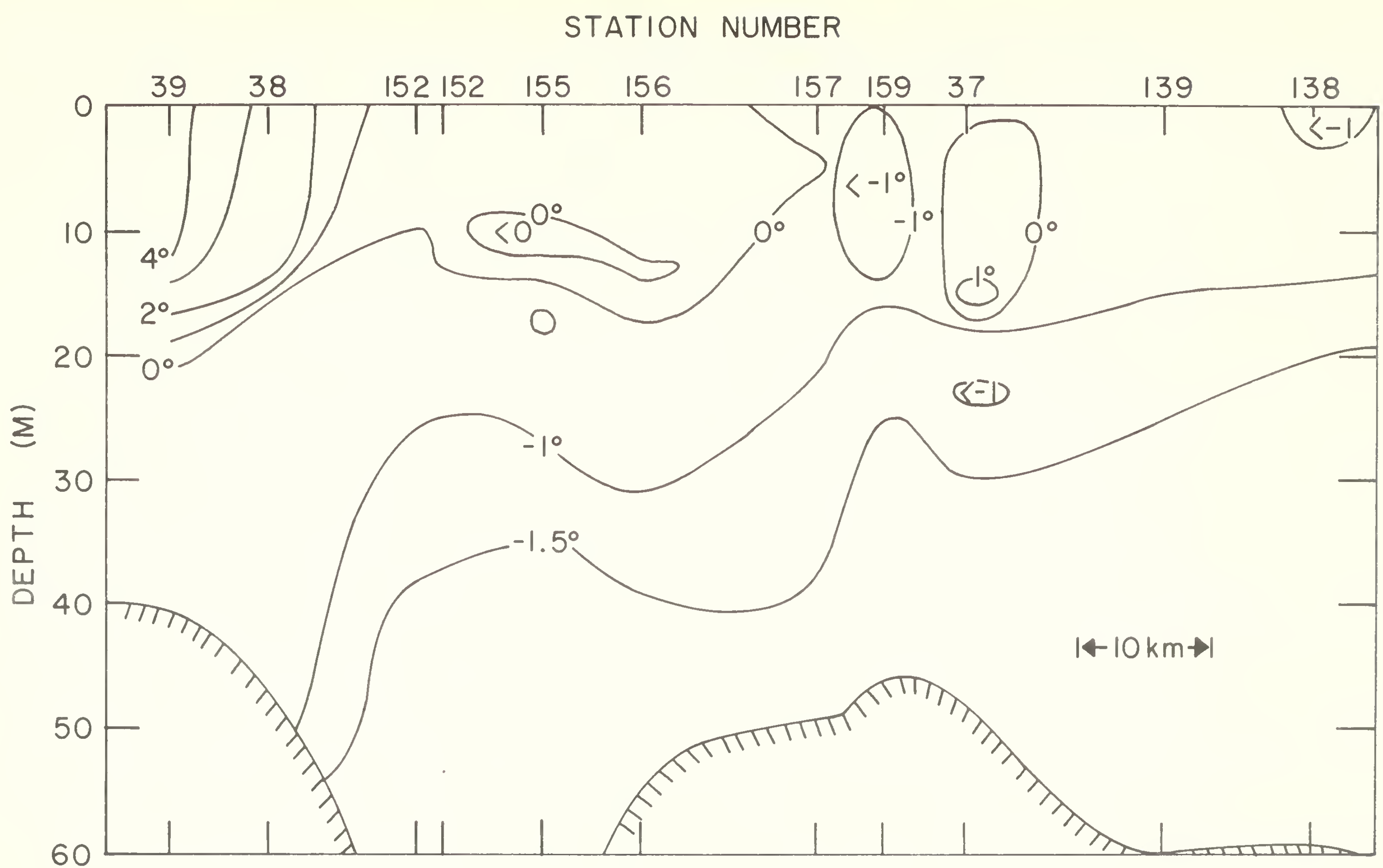

Figure 8. Temperatures in the section C - C.

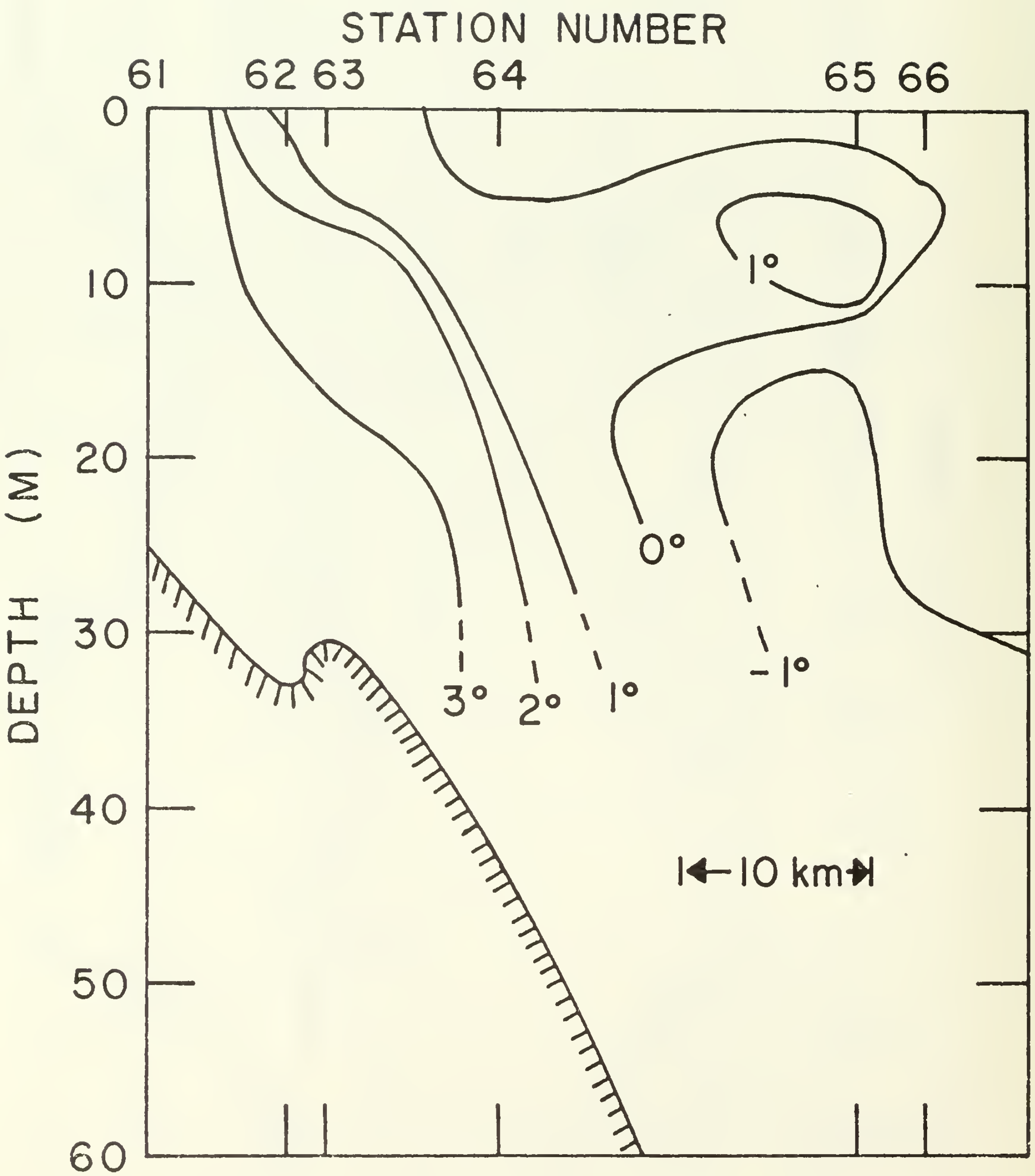

Figure 9. Temperatures in the section D - D.

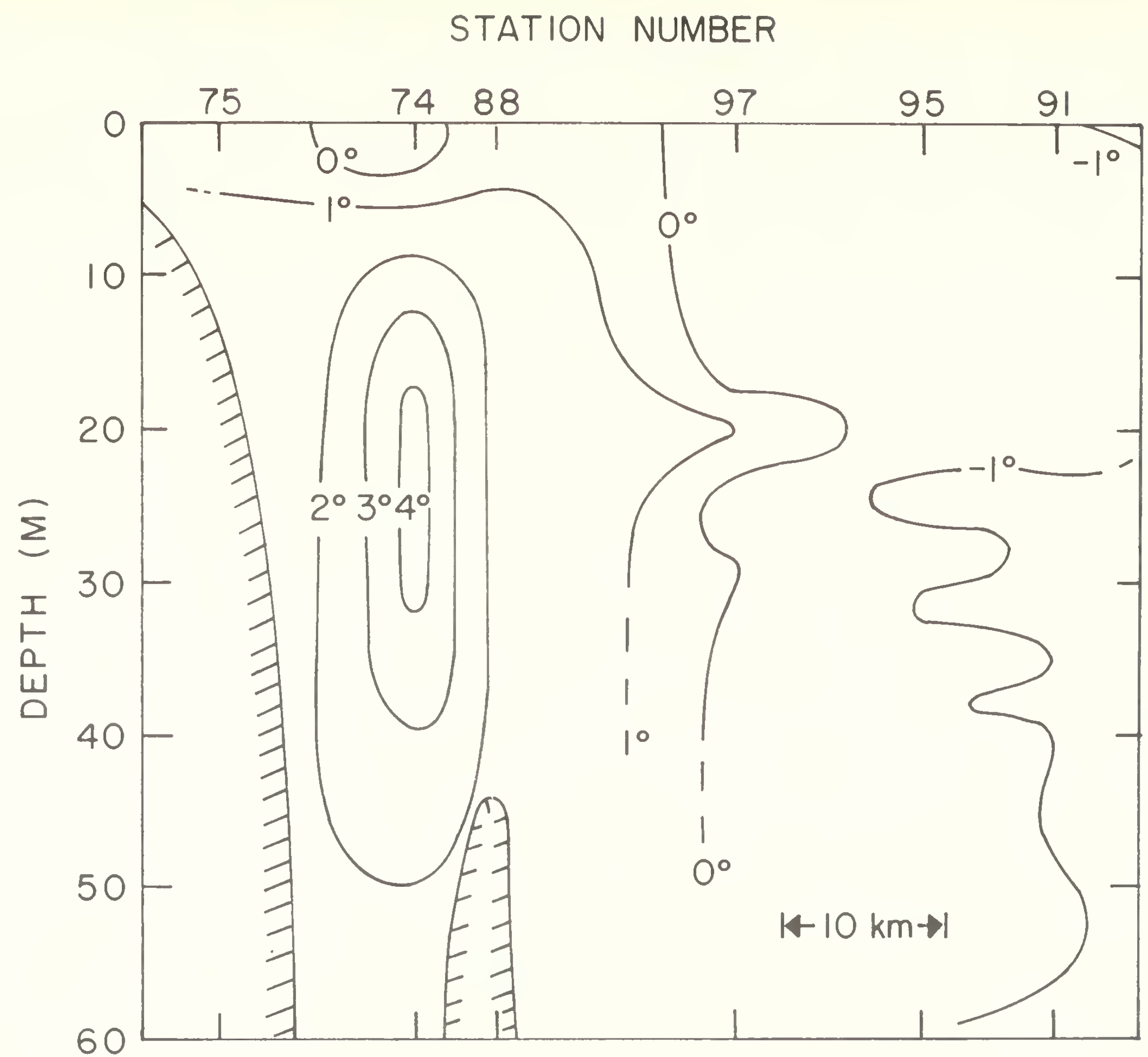

Figure 10. Temperatures in the section E - E.

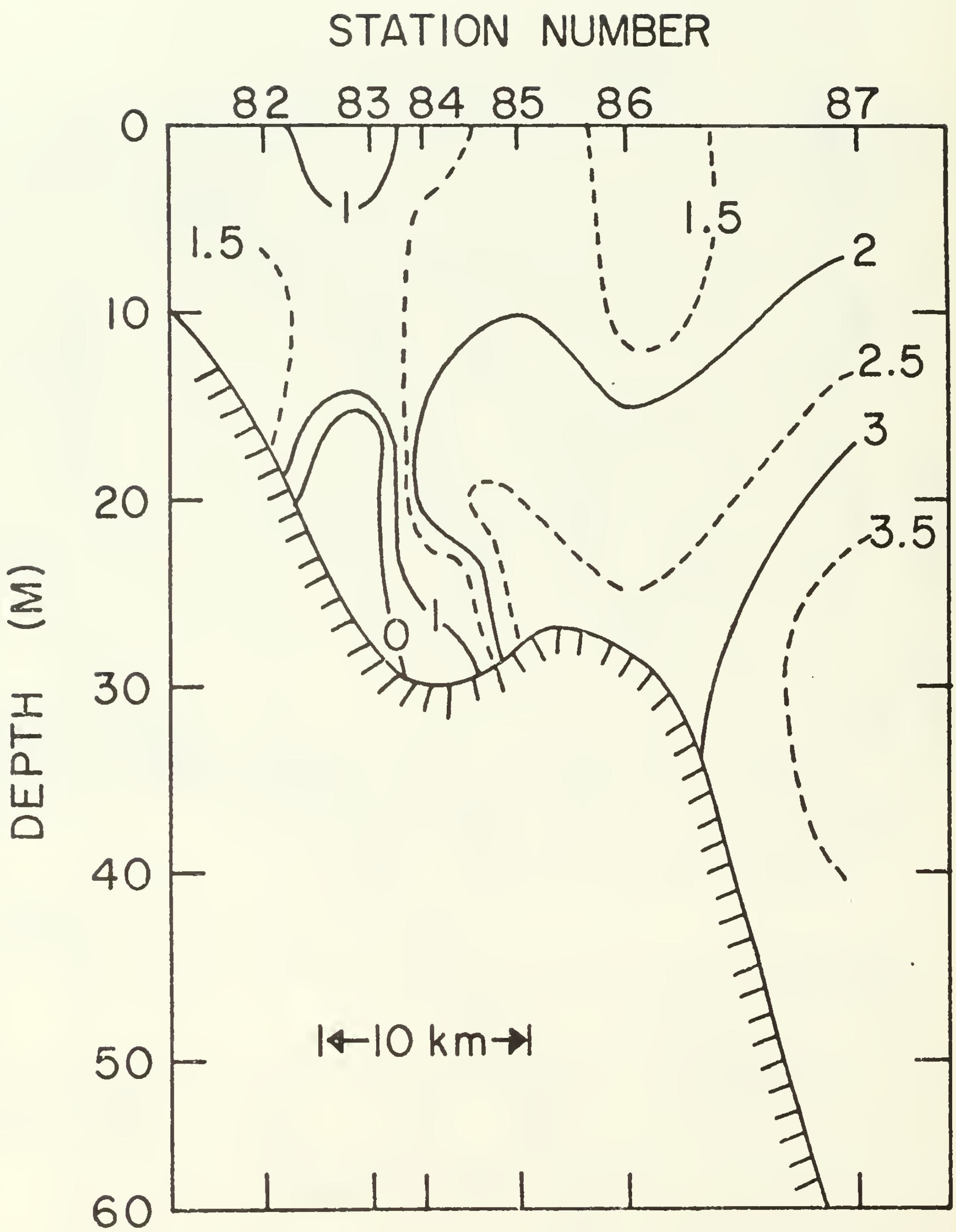

Figure 11. Temperatures in the section F - F.

longitudinal section A-A and Figures 7-11 show temperatures in five cross-sections across the coastal zone.

The following phenomena are notable in the temperature sections.

The sharp layering of warm water over cold water in the south.

The compression of the warm water against the Alaskan Coast of the Chukchi Sea. This is probably due to geostrophic forces.

The cooling at the surface toward the north, due mainly to the contact with ice. This process generally tends to form a warm nose in the temperature profile which eventually is nearly eliminated at the most northerly stations.

The disappearance of the underlying cold layer near Station 60. This is believed due to the flow of this layer down slope to a deeper equilibrium level in the Arctic Basin.

The turning of the warm water into the Beaufort Sea and its travel eastward to near the limits of the survey area.

The descent of the warm layer to mid-depth in the Beaufort Sea beyond the 10-fathom line.

The presence of mesostructure in the temperature profiles is usually not evident on these plots because the contour interval is too large to resolve it. These phenomena will be evident in the individual station profiles which will be presented next.

At the beginning of Figure 6 at Station 46 (Fig. 12) one sees the warm water riding on the top of cold, denser, water with a very sharp interface between the two. The upper layer is mixed at 6.3°C, and there is little or no mesoscale structure in the water column. It should be noted that the plotting program has automatically labeled the curves T, S, SV, ST for temperature, salinity, sound velocity and sigma-t and has marked the corresponding surface bucket measurements, if they exist, with small T, S, V, and Σ. If they do not exist, these marks are clustered at the left zero-depth margin.

It may also be noted that temperature curve closely represents the sound velocity profile. It will be seen that this is usually true except near the surface when the salinity becomes very low. The pressure effect is noticeable when the deeper water is isohaline and isothermal. There are a few cases where the salinity makes interesting modifications to

the velocity profile. These will be noted as the description proceeds.

A caution at this point deals with the spurious salinity spikes. These do introduce relatively small anomalies into the sound-velocity profile. To determine if a salinity anomaly is spurious, it is useful to look at the density curve which should be responsive principally to the salinity. It is likely that only very small density inversions are real, so notable density inversions are indicators of spurious salinity inversions. Temperature-induced salinity errors also may exist without forming inversions. These are not so obvious but they are of lesser consequence because they have minor effects on sound-beam distortion.

Conditions like those at Station 46 continue through Station 44 with slight surficial cooling and perhaps through Station 43 (no near-surface data), but at Station 42 (Fig. 13) cooling at the surface begins, mesocale structure begins to show above the thermocline and just below the thermocline and a distinctive nose appears in the temperature profile as a result of the surficial cooling. Station 41 is like 46, but at Station 40 (Fig 14) the thermocline has become thicker and less sharp and has taken on some structure. The effect of being closer to the ice is seen in Stations 50, 54, and 56 (Figs. 15-17): a weakening of thermocline (in 50), cooling at the surface with the formation of a nose (54 and 56), and the development of a little structure.

In Station 54 is seen the result of patching in the data from the RS5 near the surface. Near the top of the STD trace the salinity has been distorted by the temperature gradient and the inversion in sigma-t is not real.

The temperatures in the series of stations 61, 63, 65, 66, and 68 are shown nested in Figure 18. These are plotted with the curves spaced 1°C apart and with north on the left because there is less crossing of curves in that arrangement. The bottom temperature and the station number appear at the bottom of each curve. The first two of these (Sta. 61 and 63) show discrete RS5 data and give little information about mesoscale structure. Proceeding to the north into the ice several things happen simultaneously. The surface cools and the cooling extends deeper until the warm nose which first forms is only a residue of the lower edge of the warm layer. A deep mixed layer at -1.1°C appears in Station 65 and at Station 66 all of the deep water is colder than -1.5°C and a still colder layer intrudes between 35 and 60 meters. At Station 68 the deeper water is notably warmer, -1.3°C; the intruding cold layer with temperature as low as -1.67°C is still present, but thinner. Considerable temperature structure is present at Stations 65 and 66. It may also be present at Station 63 and in the upper portion of Station 68 whose surface temperature is recorded as 0.3°C, 1.4°C warmer than at 15 meters.

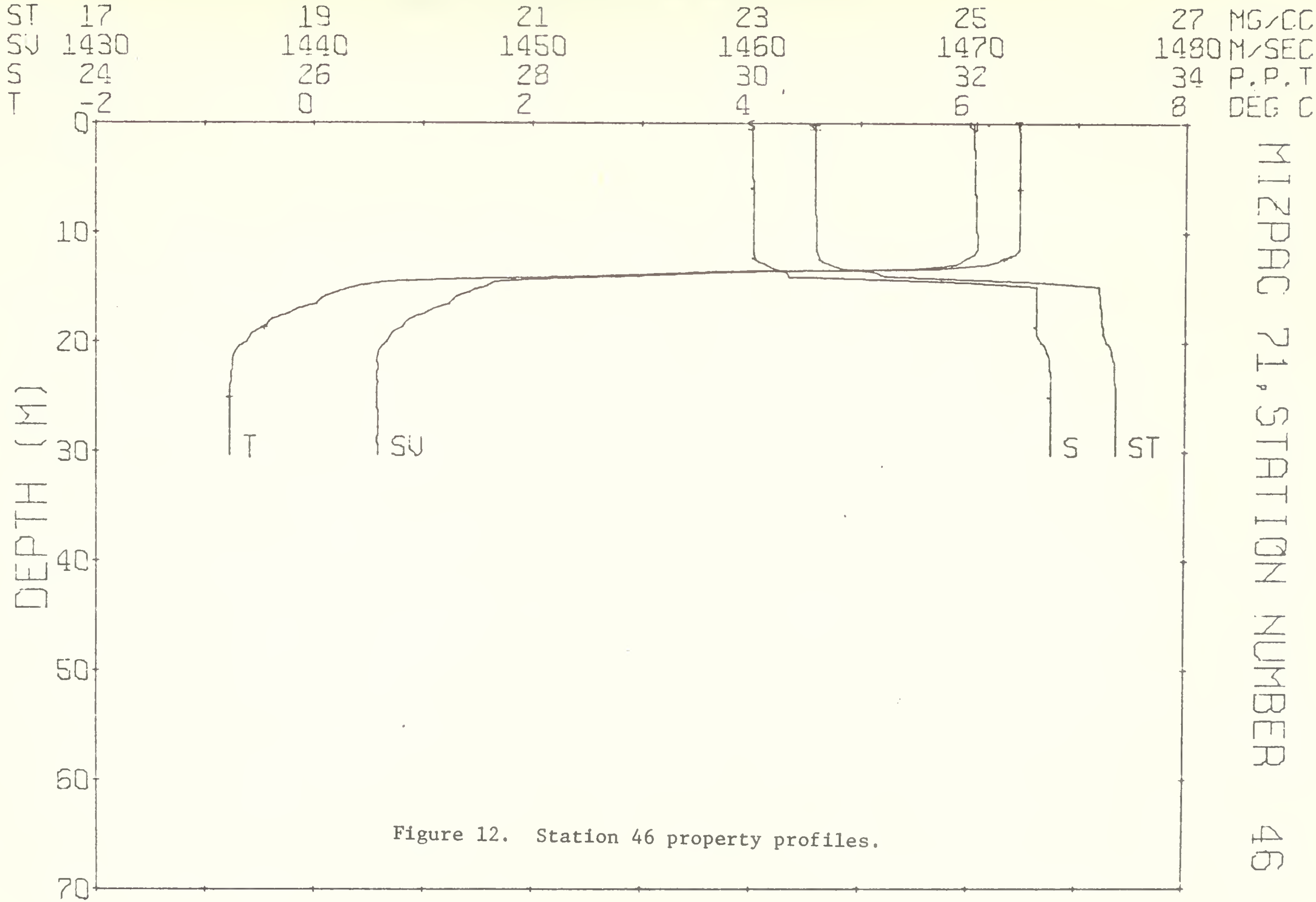

Figure 12. Station 46 property profiles.

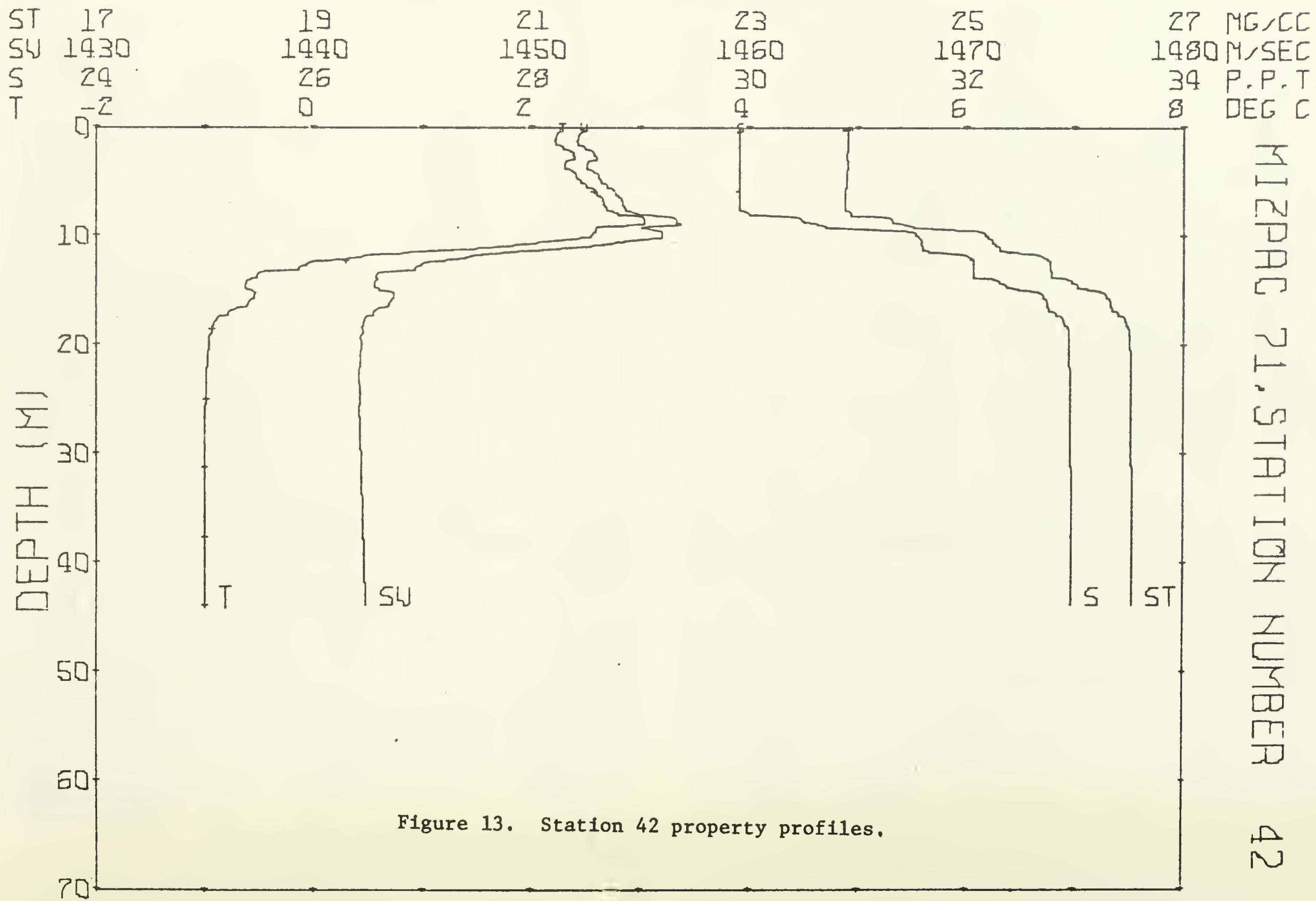

Figure 13. Station 42 property profiles.

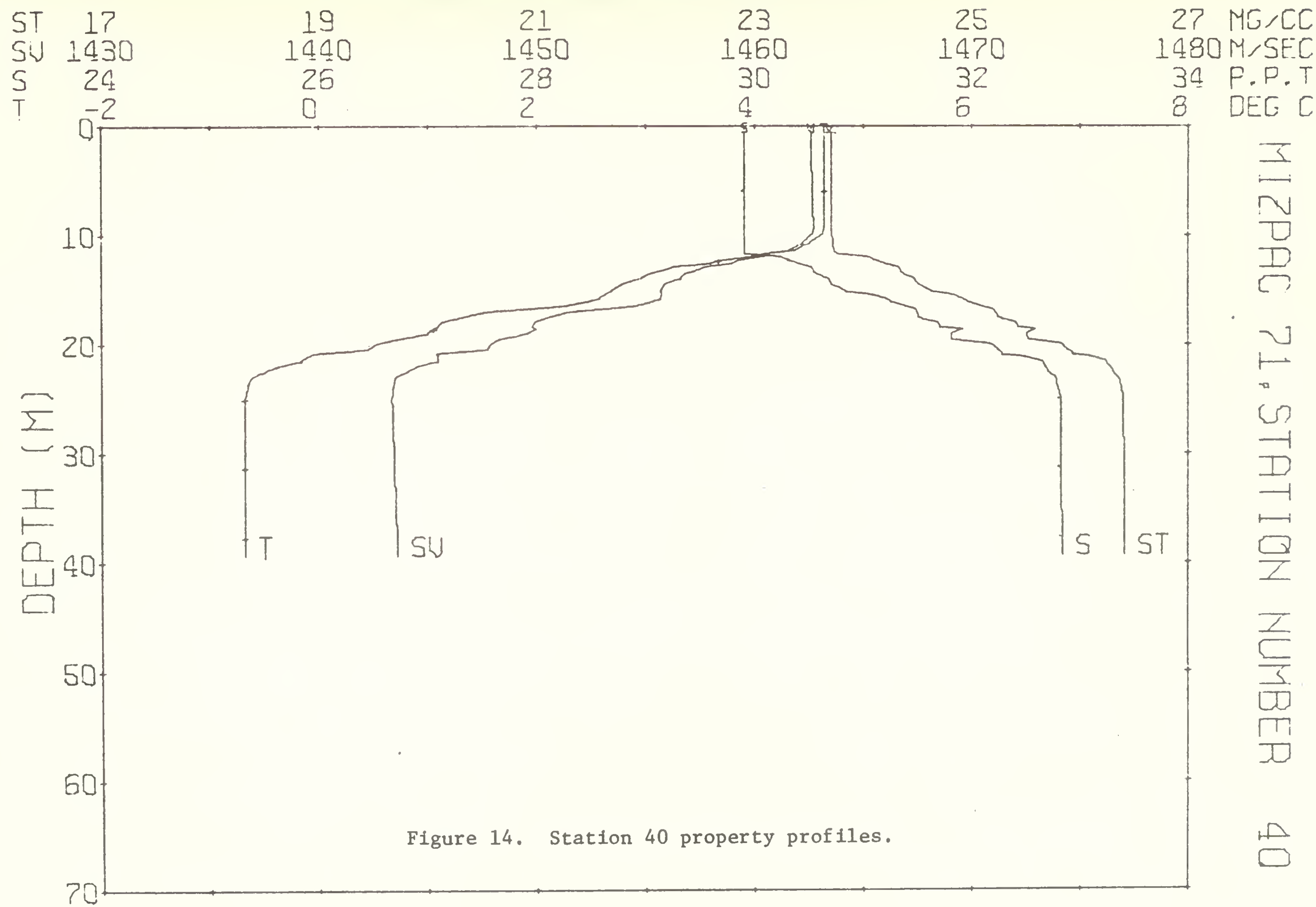

Figure 14. Station 40 property profiles.

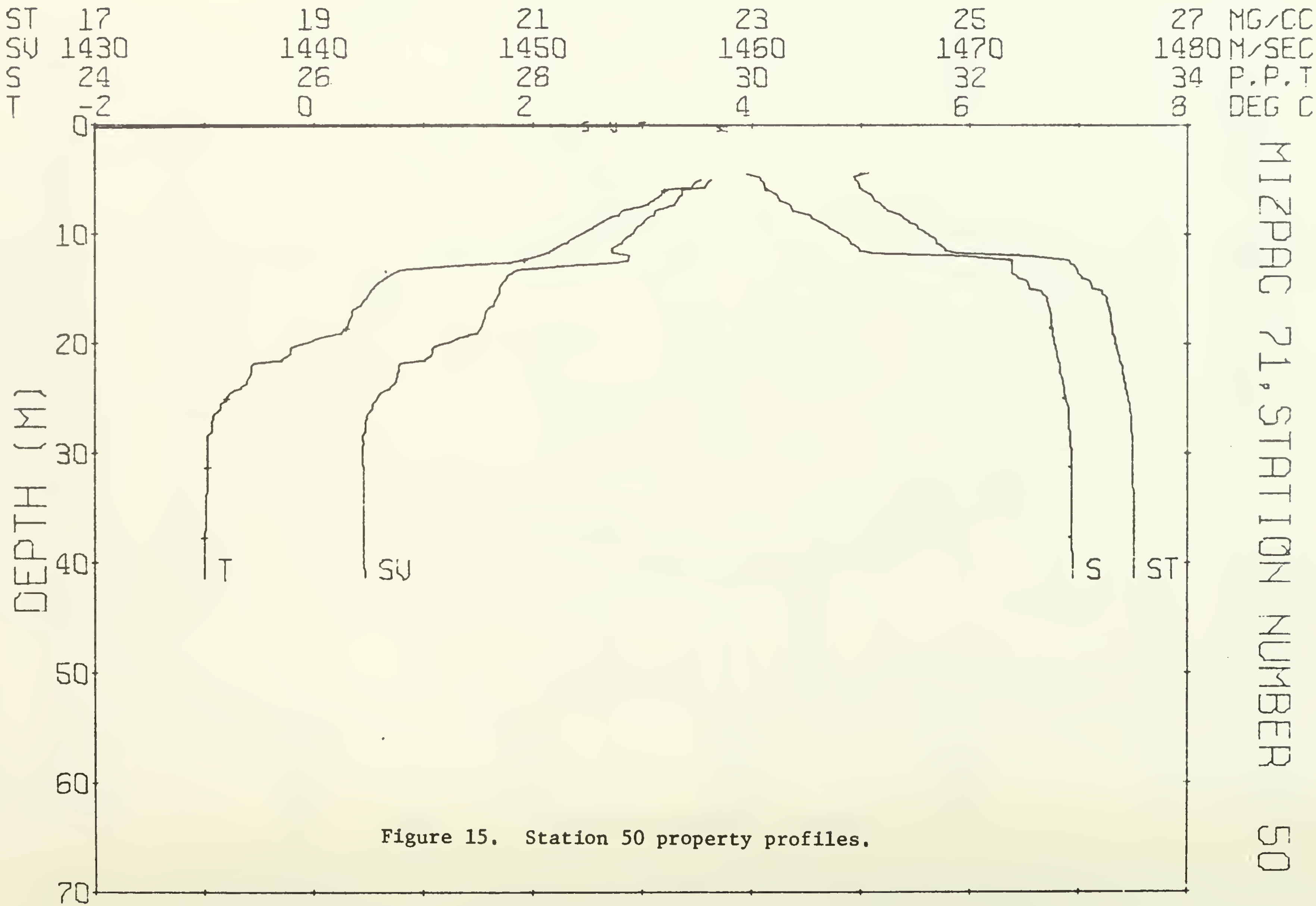

Figure 15. Station 50 property profiles.

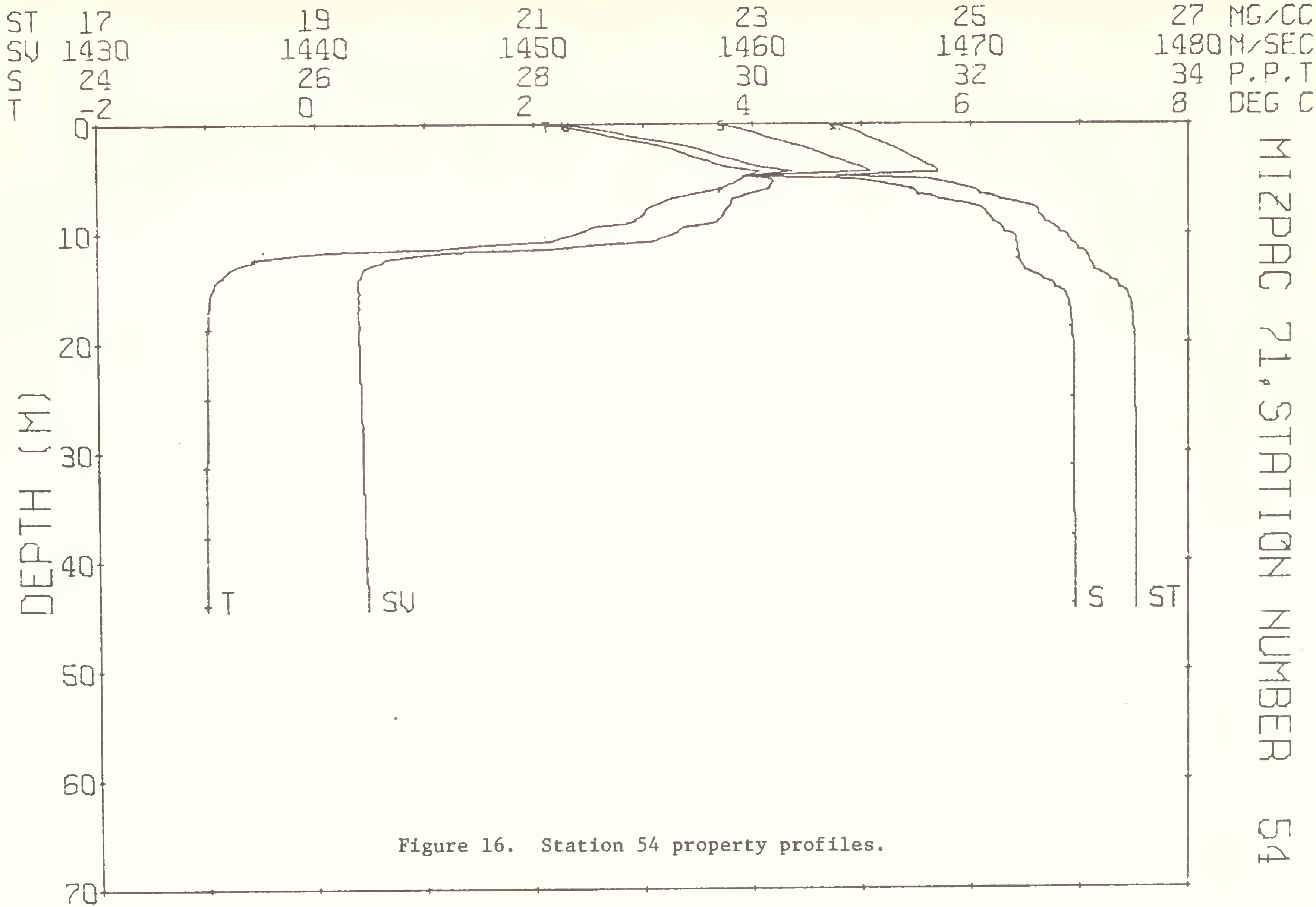

Figure 16. Station 54 property profiles.

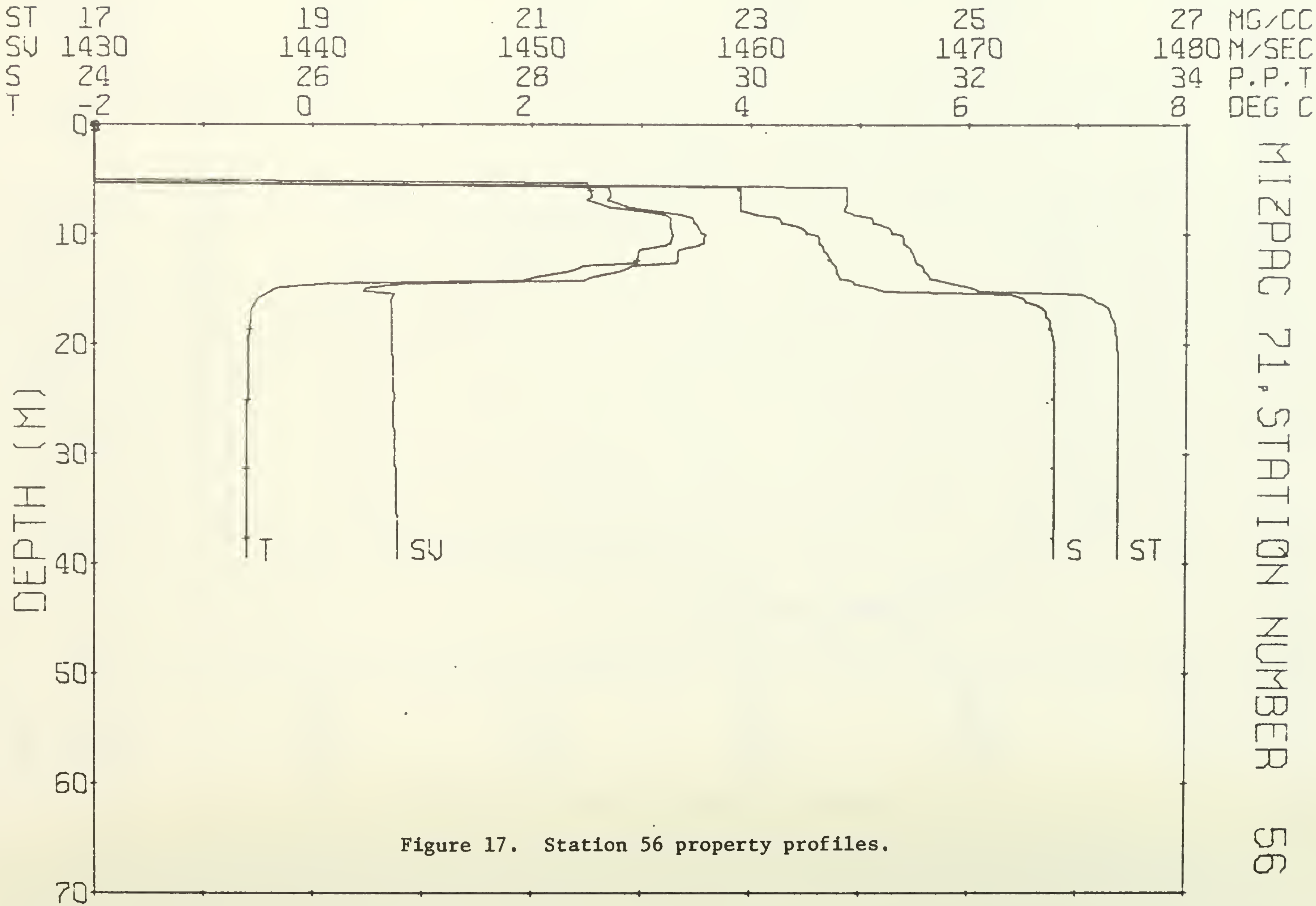

Figure 17. Station 56 property profiles.

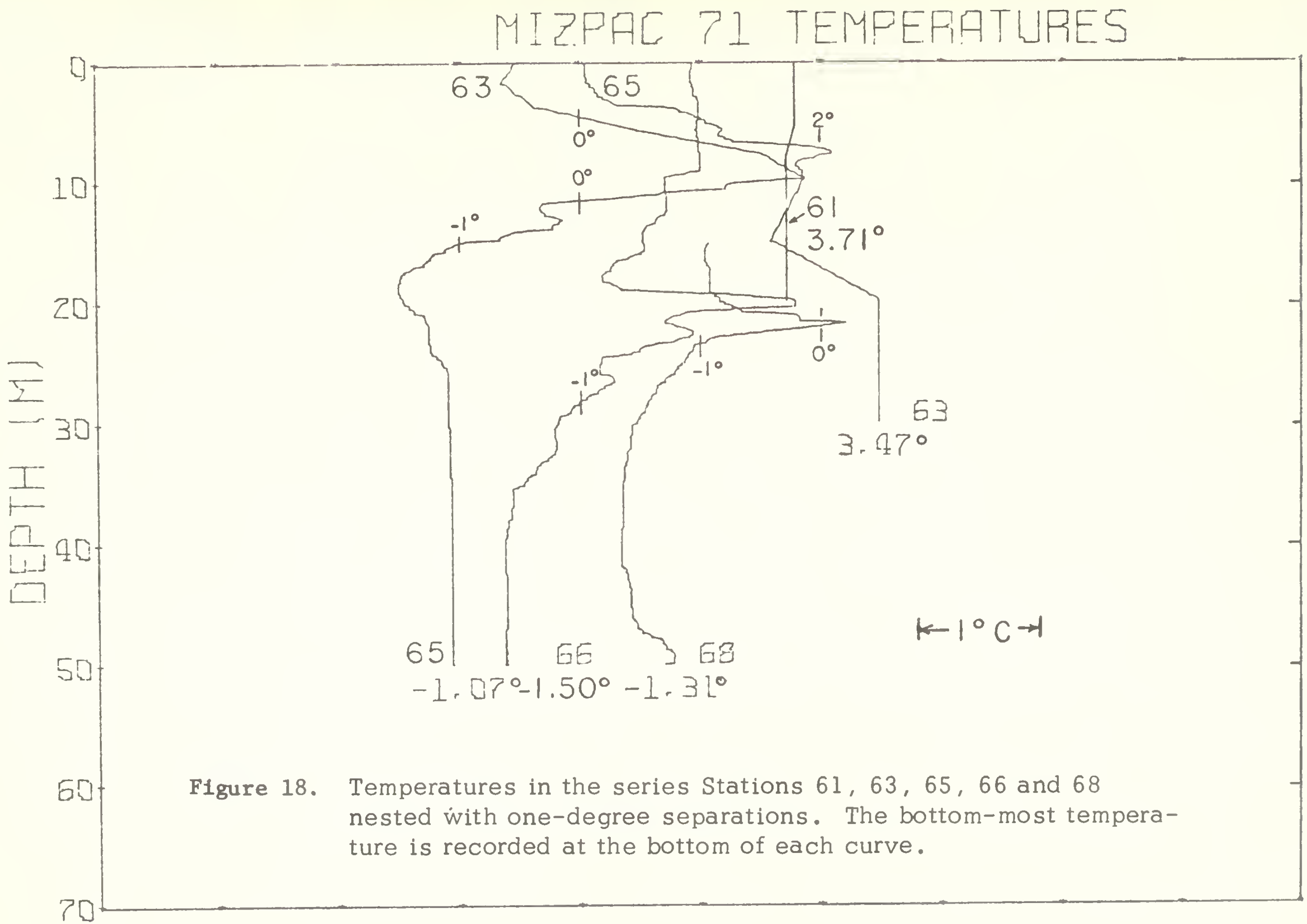

Figure 18. Temperatures in the series Stations 61, 63, 65, 66 and 68 nested with one-degree separations. The bottom-most temperature is recorded at the bottom of each curve.

There can be little doubt that this is a region which is exceedingly active oceanographically. The multiplicity of different layers can come only from an interleaving of waters with nearly the same densities but different temperatures. The melting of ice, cooling and diluting one type of water, must create these differences in relation to water not so cooled.

That structures typical of Station 66 extend well into the ice may be seen in Figures 19 and 20. These are temperatures from a 23-hour time series at non-uniform time spacings ranging from 1 to 1.5 hours with an average of 1.3 hours. These are in the vicinity of the first ice station on 2 and 3 August. Stations 17 to 35 are shown spaced $1^{\circ}C$ apart. These stations are in 6 oktas ice concentration about 30 miles inside the one-okta contour.

It is surprising to find this much structure so far inside the the ice. It is seen that the one distinctly stable feature is the warm nose at about 10 meters depth. An S-shaped feature (a secondary minimum - maximum- minimum) between 18 and 25 meters depth persists to some degree between Stations 28 and 34, a period of 6.5 hours. There also is a distorted step just above the top of the deeper cold water which is just at the bottom of these traces. Other smaller features generally do not last for an hour.

An estimate of size scale depends on relative water speed between the drifting ship and the water. Since the ship was tending the ice camps at this time, the measurements of currents relative to the ice reported by Garrison and Pence (1973) are appropriate. These authors report relative water speeds varying between 0.5 and 0.8 knots at 20 m depth and 0.25 to 0.75 knots at 10 m. One might estimate that the speeds relative to the water near bottom might be as great as the speeds of ice drift, which were as great as 1.5 knot. However, a cursory examination of the density structures shows no such currents distinctly reflected in the geostrophy relative to the local near-bottom layers. The currents near bottom therefore are probably of substantial magnitude and it would be surprising if the speeds relative to the surface were much greater than one knot.

From the present data, therefore, it may be concluded that the warm nose has wide distribution and the secondary feature below it has dimensions approximating 10 nautical miles. The smaller features which do not persist from curve to curve must be smaller than one nautical mile in extent and they may be much smaller.

On following the station plan to the points of deepest penetration into the ice, Stations 91 and 138 (Figs. 21 and 22), the residual

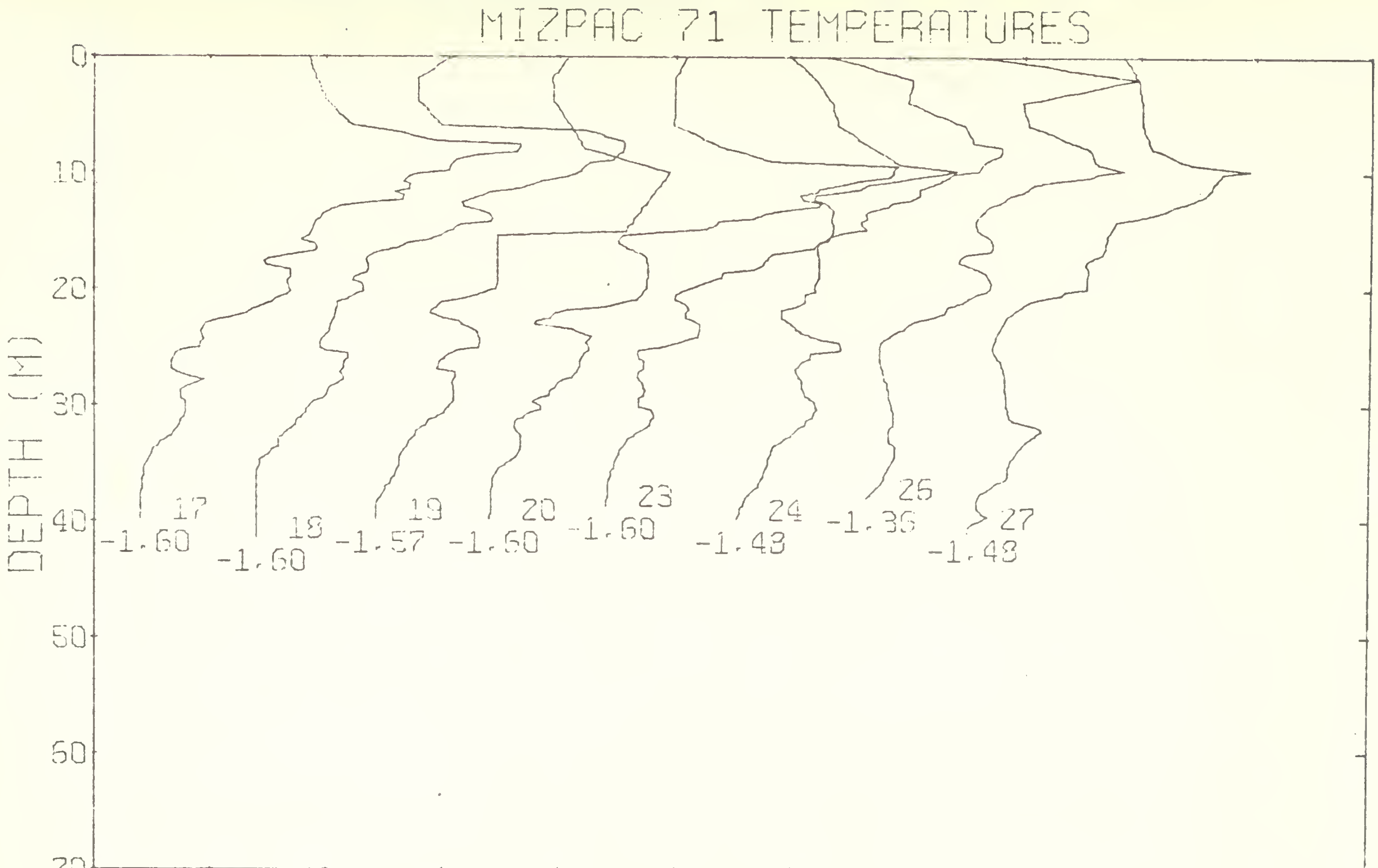

Figure 19. Time series at Zulu times: 2 August, 1630, 1800, 1900, 2005; 3 August, 0055, 0305, 0600, 0700. Station numbers as shown.

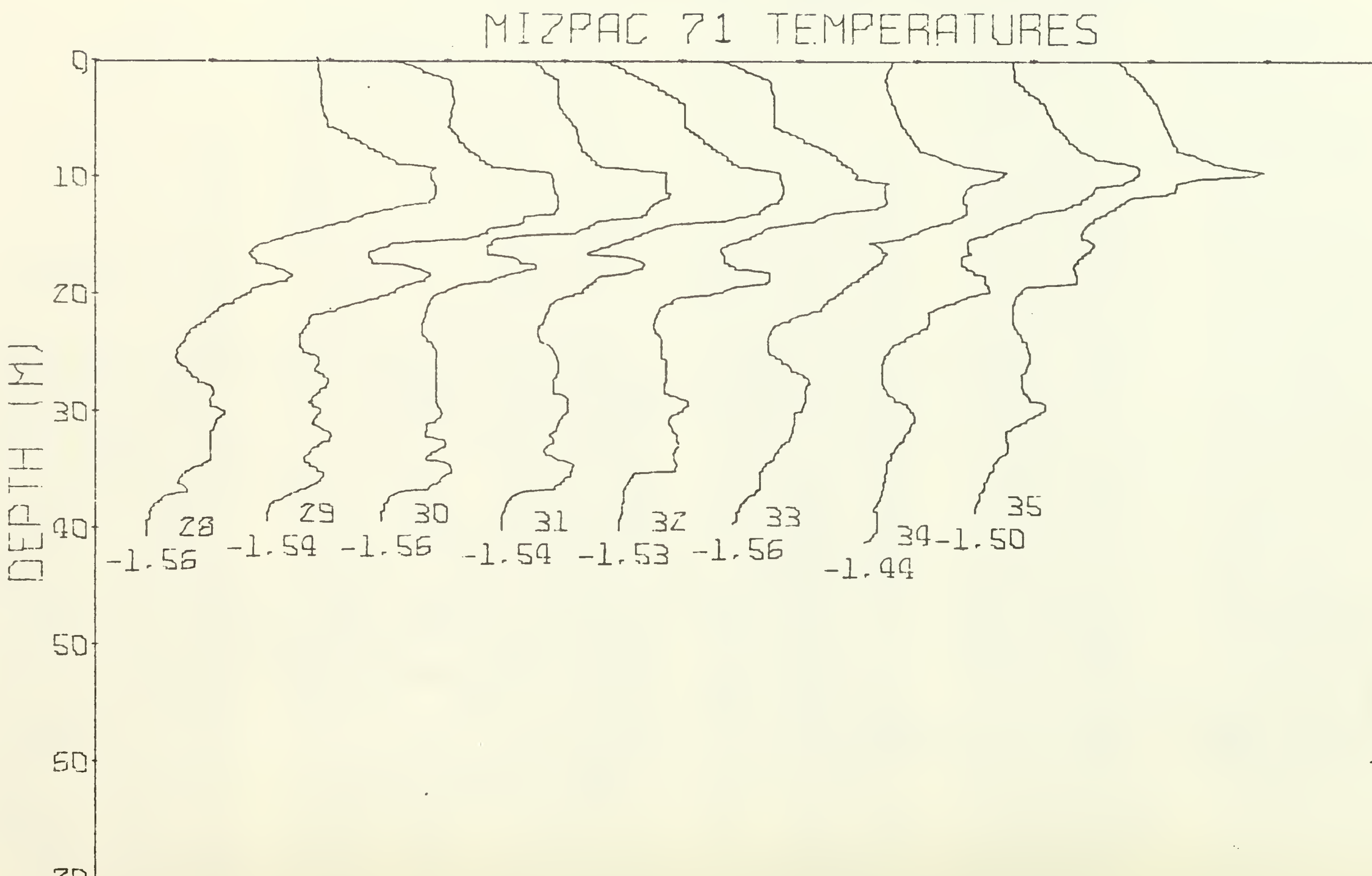

Figure 20. Time series at Zulu times: 3 August, 1800, 0905, 1000, 1100, 1200, 1300, 1430, 1530. Station numbers as shown.

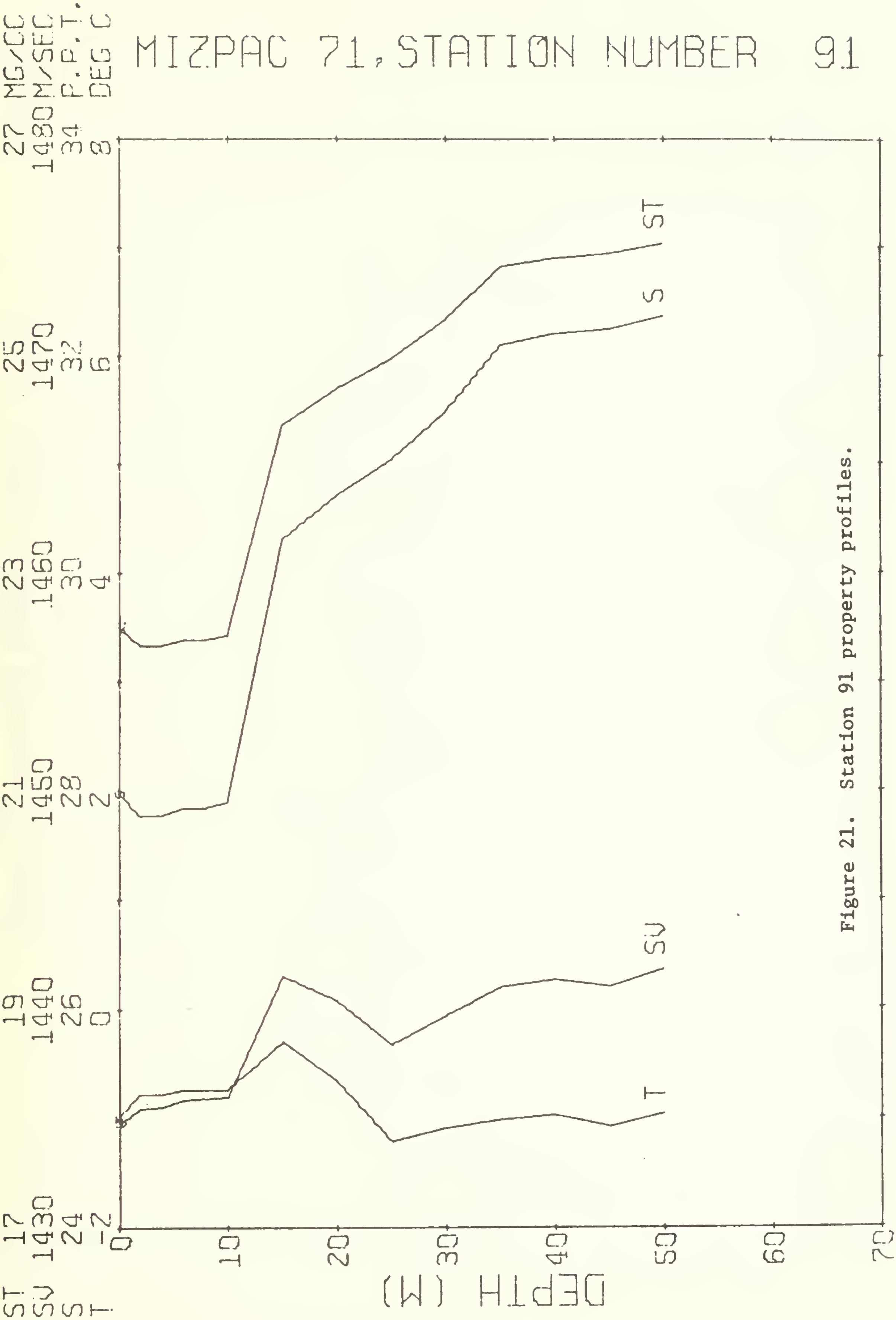

Figure 21. Station 91 property profiles.

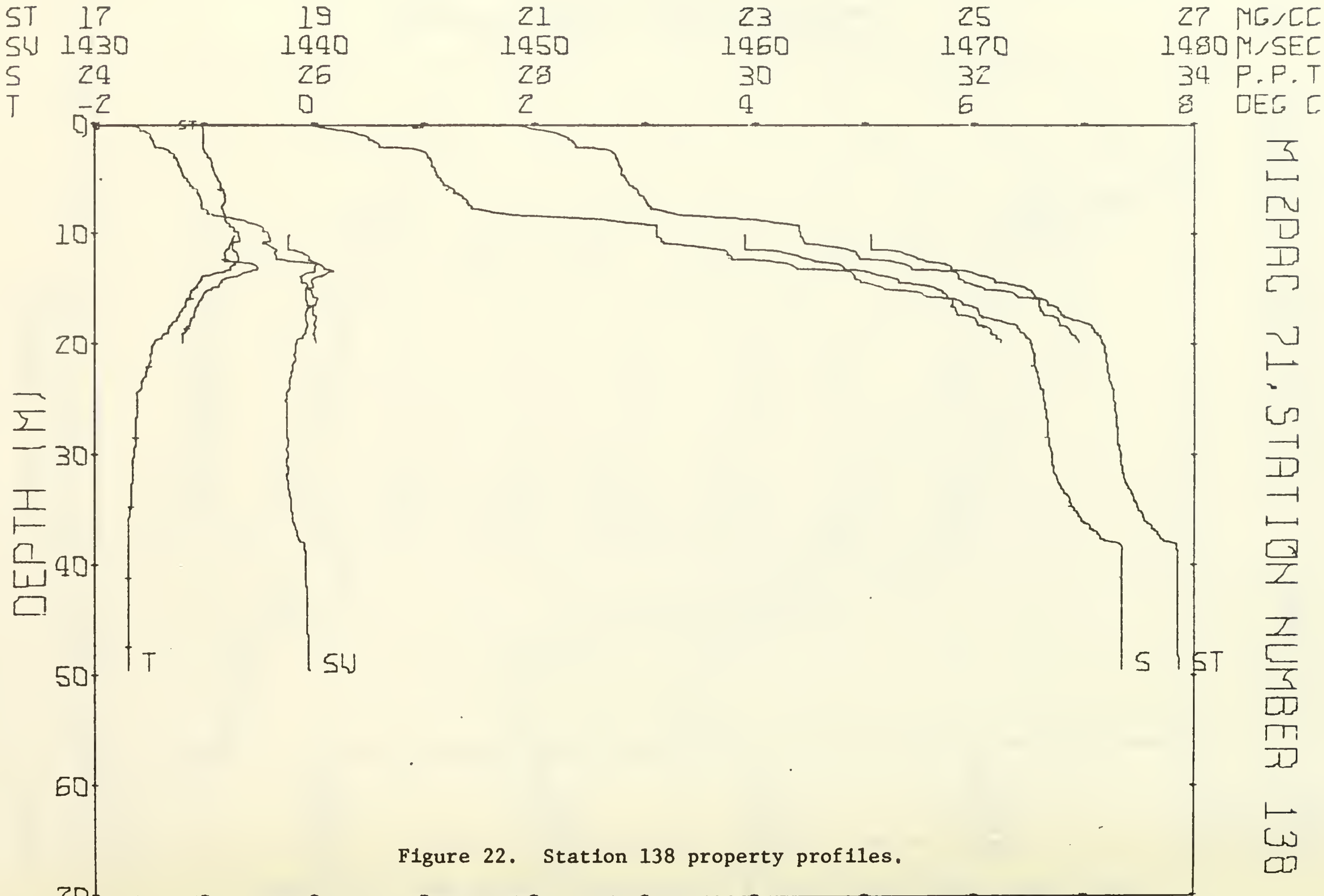

Figure 22. Station 138 property profiles.

nose of warm water is still seen. Station 138 has little mesocale structure. Because of the discrete sampling at Station 91 the structure is not visible but adjacent Station 95 (Fig. 23) has considerable structure.

Station 138 is a good example of the appearance of the shallow and deep lowerings on one graph. There is creditable agreement between the salinities on the two lowerings, although some change in water structure in the intervening time is evident. Agreement is not always so good, due principally to depth errors, which are in the vicinity of ± 1.5 meters. This also is an example of a case in which the salinity has made the sound velocity profile somewhat different in shape than the temperature profile. The difference in the vicinity of the change of slope at 13 m depth is evident. An interesting phenomenon is the appearance of a broad but weak sound channel between 13 and 37 meters because the salinity has become isohaline prior to the temperature becoming isothermal.

Eastward in the Beaufort Sea the warm current has descended to a deeper depth of equilibrium density and the temperature now increases toward the bottom. Station 87 (Fig. 24) apparently is not far enough north to demonstrate the core, but it shows 3.6°C water at 39m. At this station the STD was out of operation and all the data is from the RS5. Any mesocale structure is therefore obscured. However, Station 111(Fig. 25) which is close by has a stepwise structure.

The last point at which notably warm water was found was at Station 129 (Fig. 26) where the temperature at 24 meters was 3.3°C and some structure was still present. The stations on the Beaufort Sea shelf, of which Station 126 (Fig. 27) is an example, are cold, with low salinity and little structure. The water does warm a little toward the bottom, however, indicating that some of the warm water has found its way onto the shelf from farther offshore.

Hufford's (1973) area of coverage begins at 154° W and extends to 144° W. He succeeded in getting his outermost stations about 90 km offshore, 18 to 55 km seaward of ours in the three degrees of overlap. His findings complement ours neatly. He finds the warm water at depth at his farthest seaward stations and his depths are great enough that the core is clearly indicated as centered at about 25 meters depth with cold water above and below. He finds warm water at least as far east as 147° W and it appears that the warmest water is on the most northerly margin of his survey area. This suggests that the core may be still farther to seaward and that it may continue farther east at a distance farther from shore than it is practical to penetrate with icebreakers. Hufford also shows that warm water was found in a number of previous

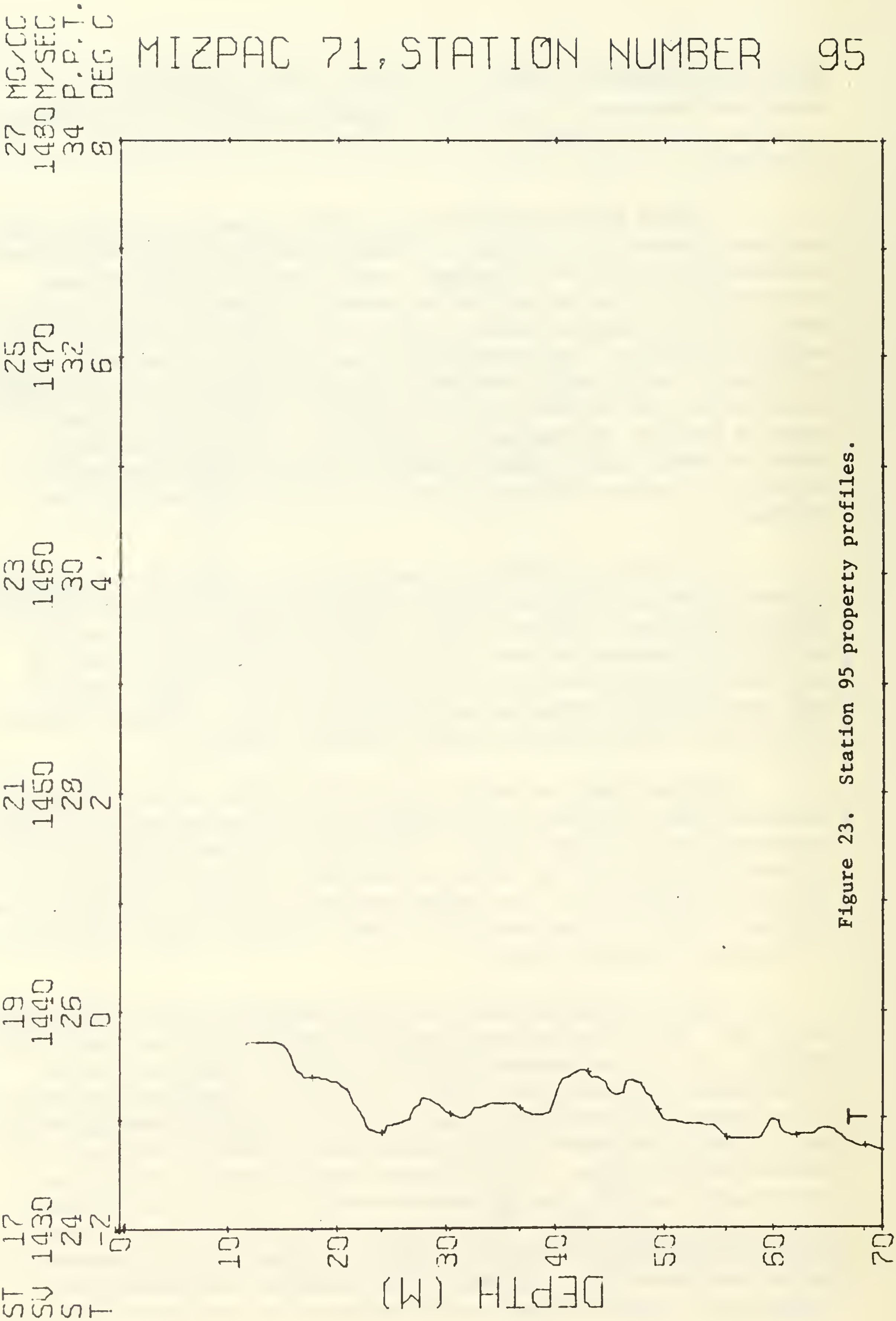

Figure 23. Station 95 property profiles.

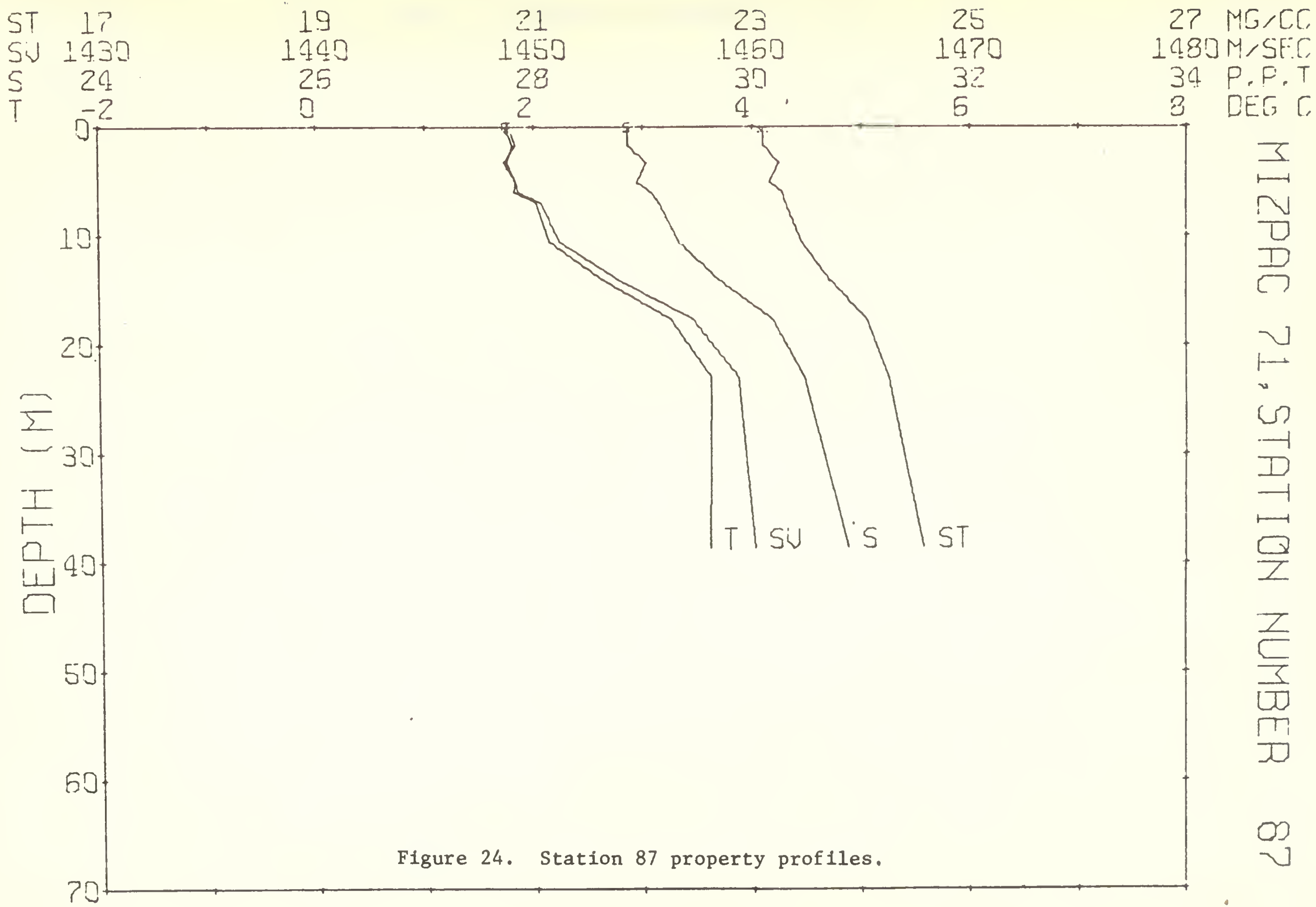

Figure 24. Station 87 property profiles.

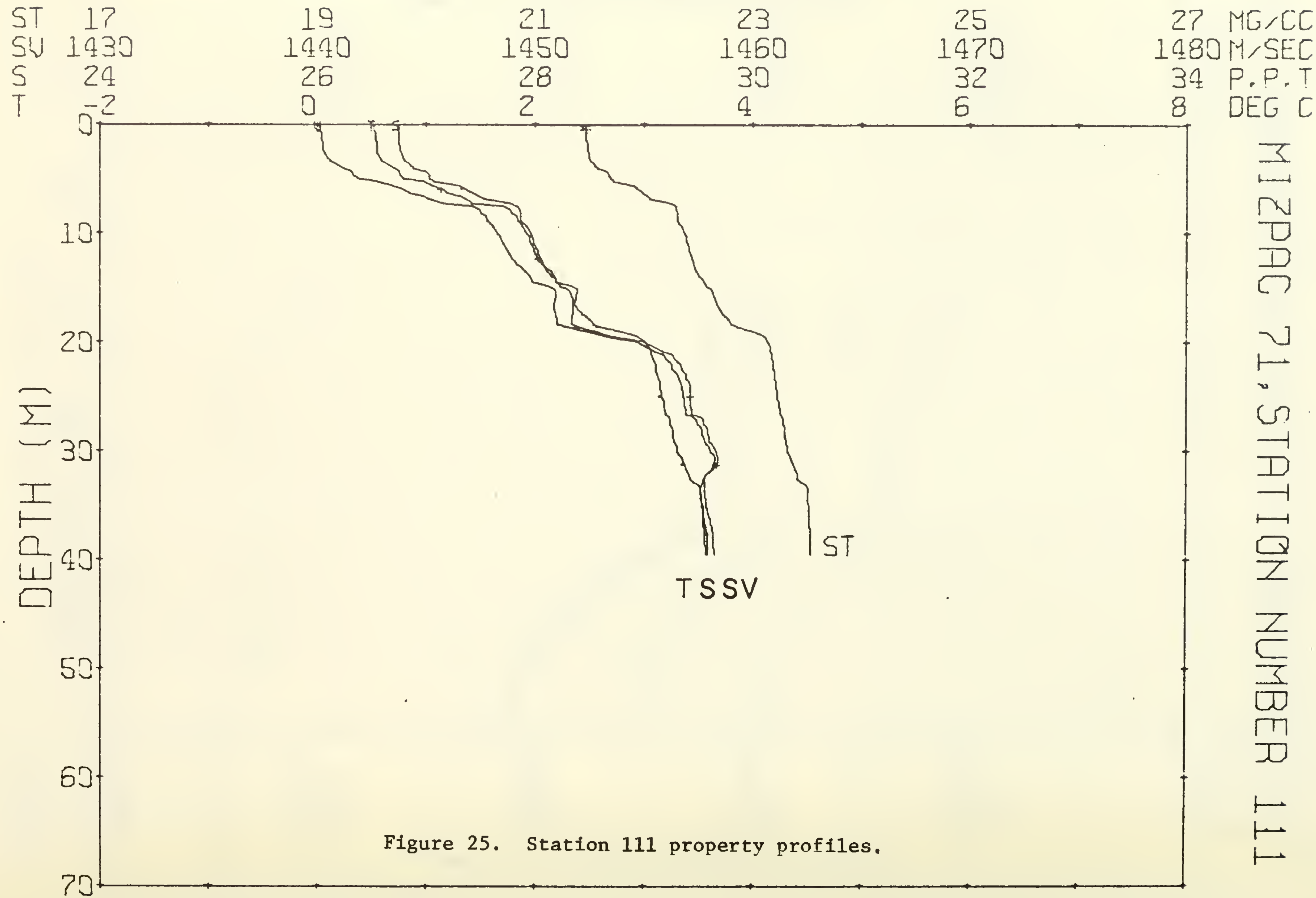

Figure 25. Station 111 property profiles.

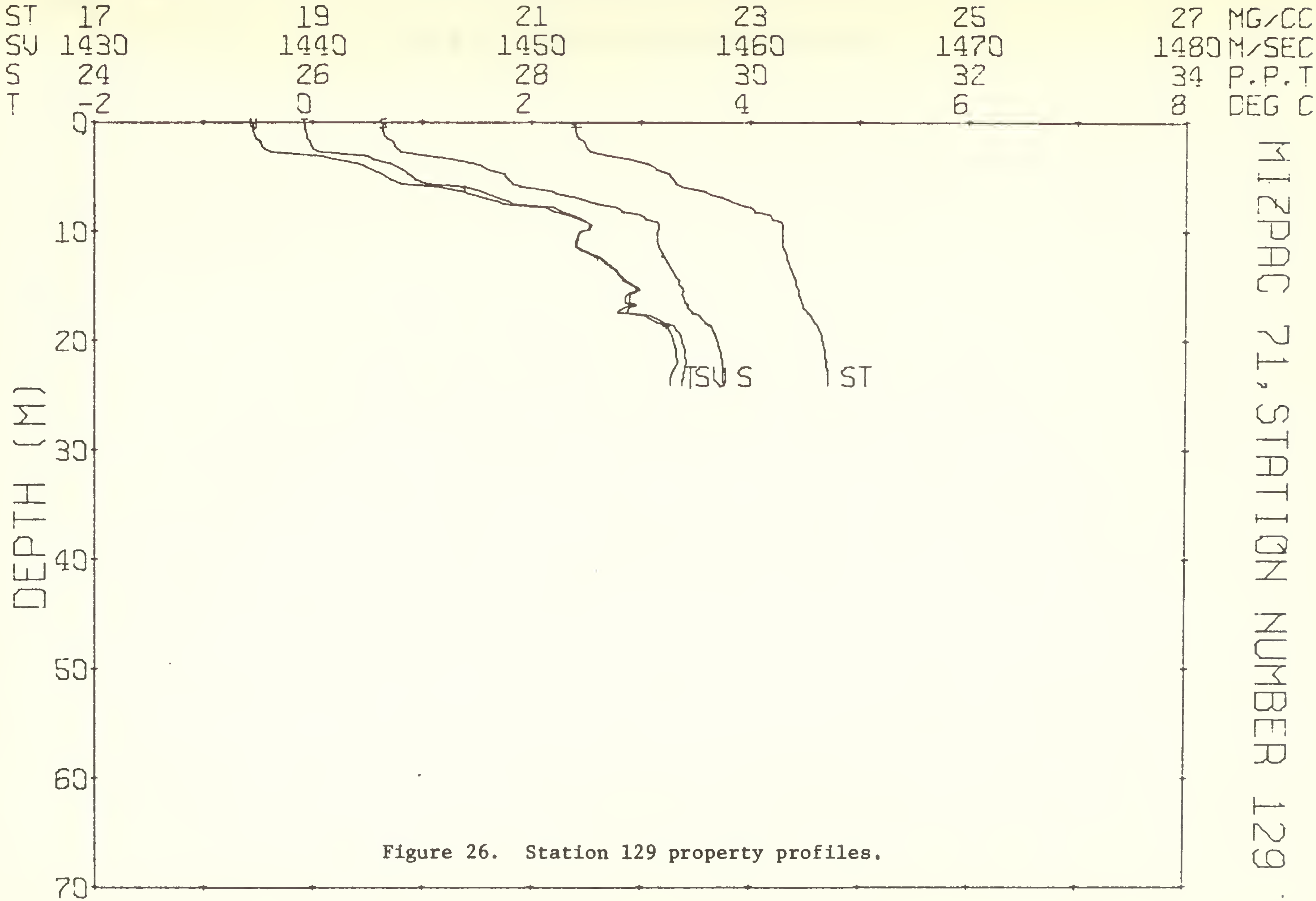

Figure 26. Station 129 property profiles.

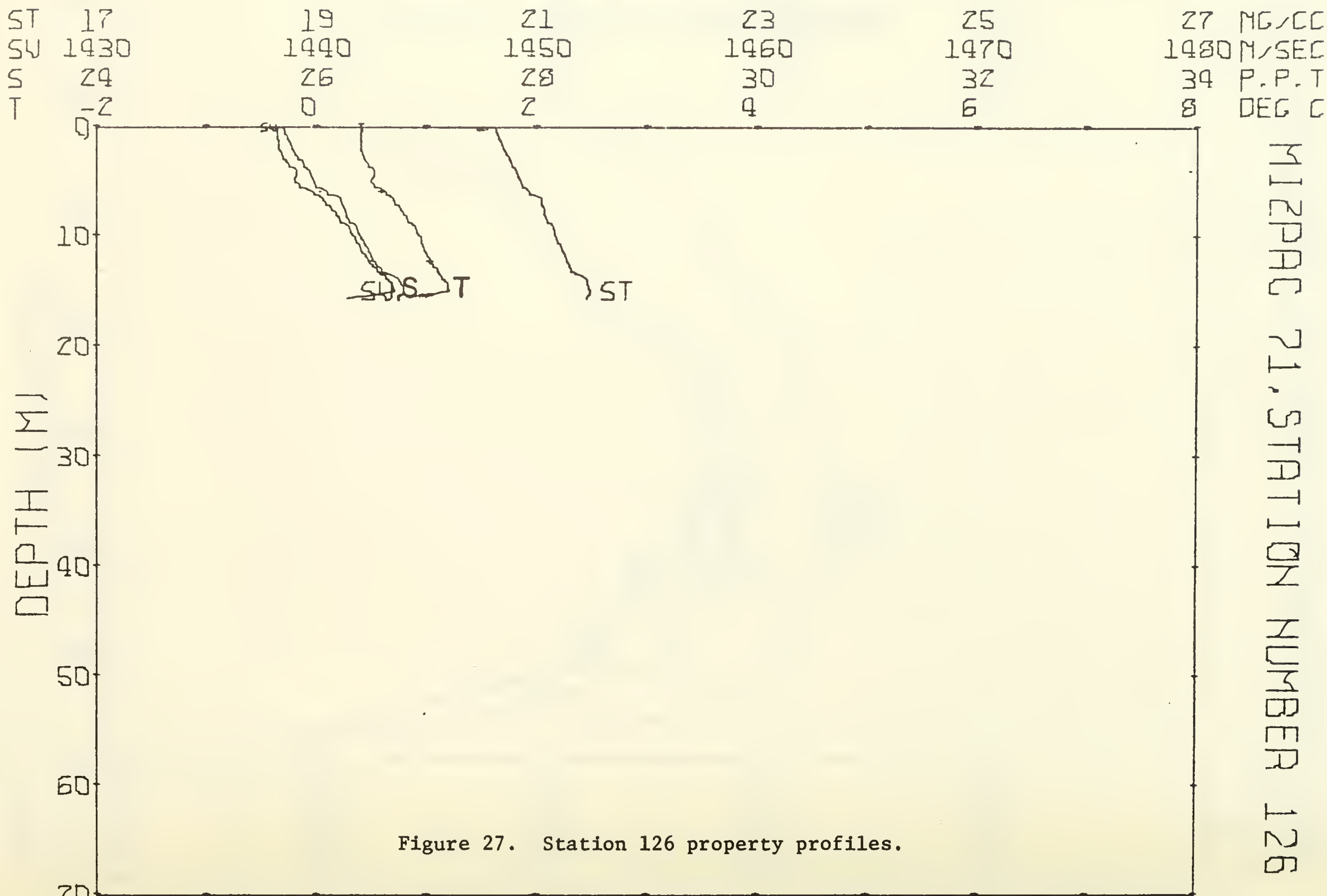

Figure 27. Station 126 property profiles.

summers, varying substantially in temperature. Its apparent absence in some years may be due to station distribution.

The general situation in the costal area of the northern Chukchi and the western Beaufort Seas may be summarized by means of a single diagram. This time, sound velocity will be shown at Stations 46, 66, 74, and 114 in Fig. 28. Detail may vary greatly with time and position. Station 46 with two sharply interfaced layers is typical of the coastal current distinctly south of the ice. There is little finer structure. Station 66 shows the effect of considerable surface cooling. It is in the Barrow Sea Valley, so shows the effect of cold high-salinity water near the bottom. This station is fairly representative of all the stations further into the ice except for depth. It has a residual warm nose, deeper than the original warm-water layer and it has considerable finer structure. Toward the south and southwest from Station 66 larger noses exist caused by moderate surficial cooling of a structure like Station 46. Station 74 represents the beginnings of the entry of the warm current into the Arctic Basin. It is well cooled at the surface and has a temperature maximum at 20 meters where the core of the warm water has descended to a deeper equilibrium density level. This station probably has finer structure which does not show because the RS5 was used. Finally, Station 114 is probably typical of the water along the Beaufort Sea slope. The warm core has descended to 30 meters and colder water is beginning to appear underneath. The fine structure is mild.

Although there are many stations at which only RS5 data are available, often obscuring fine structure, there are enough continuous temperature traces to strongly suggest that there is at least moderate mesoscale structure throughout the zone of active interaction of the coastal current and ice. This extends through the entire area surveyed, from the southern boundary of the ice to the more northerly boundary between Stations 91 and 103. In the Beaufort Sea the warm water is no longer near enough to the surface to interact actively with the ice and mesostructure is mild.

E. CONCLUSIONS

The data taken in MIZPAC 71 are nearly everywhere dominated by the warm coastal current having its origin in Bering Strait. This current turns eastward just beyond the turn of the 10-fathom depth curve about 25 km northwest of Pt. Barrow and continues to beyond 152°W, the limit of adequate sampling. Hufford has shown it extending to at least 147°W and shows it present in historical data. It, therefore, is present in the Beaufort Sea most of the time in the warmer parts of the summer.

Before encountering ice the warm water, at about 6°C, was a

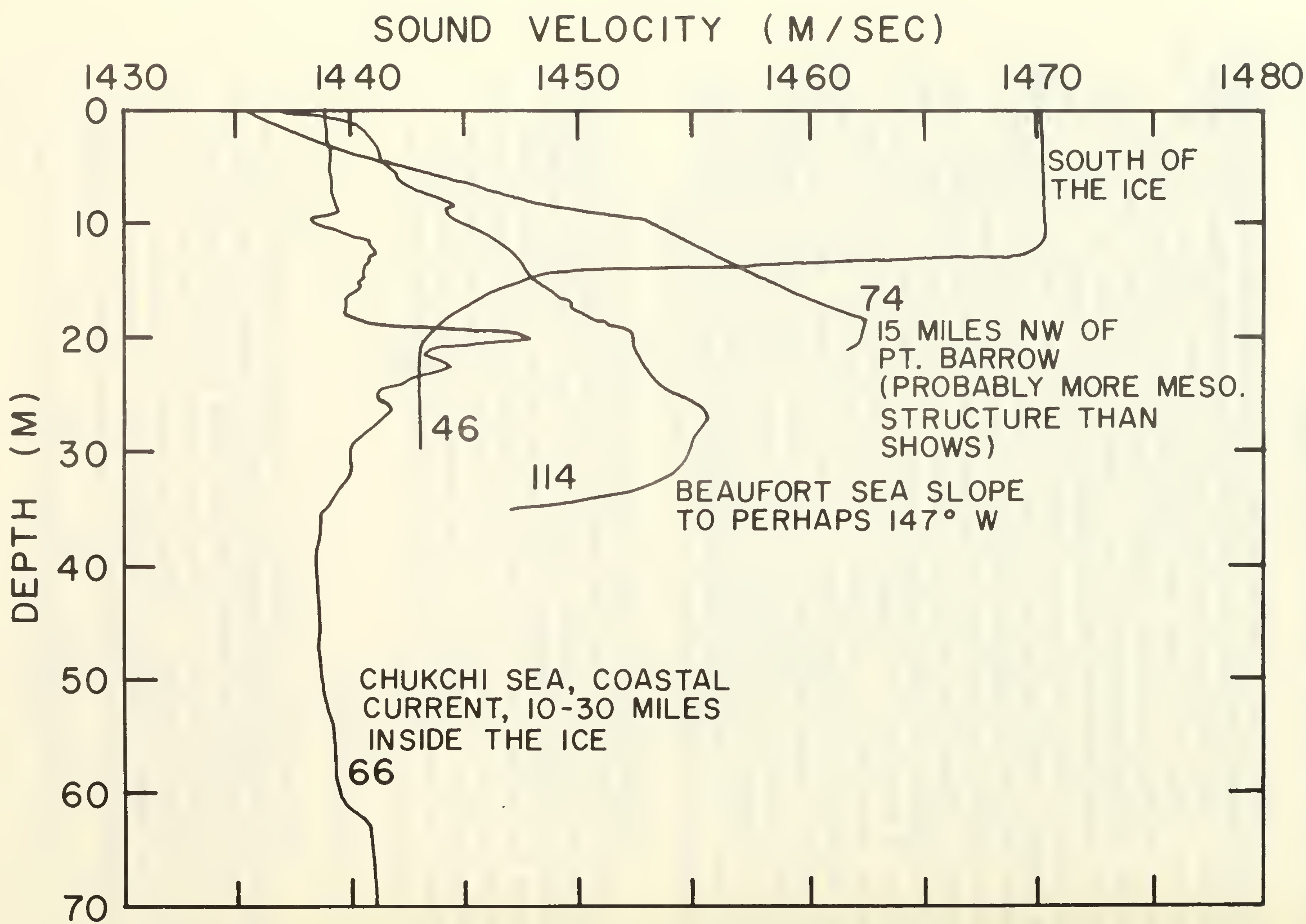

Figure 28. General types of sound-velocity profiles in the coastal current of the northeastern Chukchi and southwestern Beaufort Seas.

layer about 13m thick riding atop a dense layer of cold relict water. On contact with the ice the surface cooled, leaving a warm nose below. This warm nose was colder and thinner, the farther into the ice the station. Vestiges of the nose were still present 65-85 km from shore.

In addition to the warm nose there was notable mesoscale temperature structure, difficult to describe generally. Typically there were several sharp oscillatory deviations from a smooth curve, often one-sided protuberances varying from $\pm 0.2^{\circ}C$ to $\pm 0.8^{\circ}C$ in magnitude and 2-4 m in thickness, the smaller ones most common. Still smaller deviations were more numerous. These mesoscale deviations were absent in the deep cold water. However there was at times a second colder or warmer layer causing a broad step near bottom where the water was deeper than 40 m.

In the Beaufort Sea the warm layer had descended to 25-40 m depth, its southern edge lay against the continental slope, its core was at least 60 km off shore at the most northerly station. Judging from Hufford's work, the core was perhaps 100 km offshore farther to the east. One might speculate that the warm stream may have as much development north of the core as to the south. This would suggest that warm water extended another 40-60 km seaward to 100-160 km from the Beaufort Sea shore.

In this part of the Beaufort Sea the principal major feature was a warm bulge with temperatures as high as 4° C and thickness 25-30 m. Mesoscale structure was less pronounced than it was before the warm water descended to its mid-depth position.

III. MIZPAC 72

A. INTRODUCTION

MIZPAC 72 occurred at nearly the same time of year as MIZPAC 71, 31 July to 19 August 1972. The ship was USCGC BURTON ISLAND. The cruise devoted attention exclusively to the Chukchi Sea and had many of its stations farther west than the limits of the coastal current, to 167° W. Closely spaced stations crossing the ice margin were occupied in a number of places. It went farther north than in 1971, to 73°-20' N.

Whereas 1971 was a "normal" year for ice, 1972 was a year of more than normal melting. Also, in 1972, the ice margin was relatively compact in contrast to the fairly diffuse ice margin of 1971.

Equipment problems were distinctly less serious. A better STD was used and a shunt was in readiness to make recording possible

in the upper layers. One hundred fourteen stations were occupied, most of them with two lowerings. The heading data for these stations are listed in Appendix I. These headers differ from 1971 only in the presence of SORD in Column 69 and the addition of a negative exponential description for ice concentration described in Appendix I.

B. TECHNIQUES

The STD was a Bissett-Berman Model 9006 supplied by the Arctic Submarine Laboratory. It had a 200-foot depth scale, a 30-35 o/oo salinity scale, and a -2 to +10°C temperature scale. There were more expanded salinity and temperature scales but they were used only in a few cases. The instrument was of the pen-writing type; on the expanded depth scale it produced incomparably better records than in 1971. No electrical noise was experienced, possibly due to the use of a line filter in the a.c. power supply. It was not necessary to use the Beckman RS5.

Unfortunately, the temperature compensator for salinity was no better than before. The characteristic time constant was measured and found to have a dominant constant of 2.0 seconds and one of 17. 6 seconds involving a smaller heat capacity. To alleviate the problem of spurious salinity spikes as much as possible, lowering was done at the slowest speed of the winch, 0.09 m/sec. This was about seven times slower than in 1971 but still was not slow enough to eliminate spikes when the temperature gradients were sharp. For this year, the oscillations of salinity were traced faithfully with the digitizer because we expected eventually to be able to correct the salinities and use the resulting densities in a study of mixing processes near the ice margin. This correction has not been carried out as yet.

We went prepared with a 270-ohm shunt for the conductivity cell which was the value which was used in 1971. This did not permit the entire salinity range to be covered because now there was only one wide-range scale as contrasted with six ranging from 30 to 41.5 o/oo after the recorder was shunted in 1971. This was quickly discovered and a 400-ohm shunt was constructed in the field and calibrated as before. Most of the 114 stations were done in two lowerings as in the latter part of MIZPAC 71.

The STD was standardized as in 1971 at nearly every station. At most of the stations surface salinities and temperatures were taken by way of a bucket. Surface salinities are often much lower and temperatures higher than the first reading of the STD. This is to be expected because the uppermost reading of the STD is about one meter beneath the surface skin.

C. REDUCTION OF DATA

The computer programs of 1971 were modified to record and process data on magnetic tape. This was essential because the expanded depth scale resulted in nearly five times as many data points per lowering. Recording on cards would have required about 50,000 cards. The data are on several files of a single tape with master card information as before, but the water properties are written in format F6.2, 2F6.3, F7.2, F7.4, slightly different from 1971. Tape has its awkard aspects; particularly, minor corrections and rearrangements are much more difficult to do. The final output tape may reflect this; the stations now are not in perfect serial sequence and a few faulty outputs are interspersed because it is too time-consuming to remove them. Details of the tape output are given in the appendix.

The data listings are similar to those in 1971 but only every fifth depth level was listed in order to keep the output to a reasonable bulk. Data is stored on tape at the maximum resolution, 0.0644 m; condensation by any integral depth factor is possible by parameter changes for either listing or card punching.

The plotted station data usually shows both the shallow and deep lowerings on the same plot. Occasionally, this is not possible where the two lowerings ended up on separate tape files. The shallow and deep lowerings are then presented separately or one is hand-traced upon the other. There was at times an unfortunate tendency to make the shallow lowering as short as possible with the result that there is sometimes a gap between the lowerings. Where the records overlap greatly, the curves may be difficult to separate. Hand-entered lettering is then inserted to assist the reader. Also, the temperature trace is marked with crosses and the salinity with dots every 20 depth increments. The overlaps will eventually make possible a more critiçal analysis of the behavior of the shunt.

The effect of the shunt was at first computed according to conductivity tables, based on its effect in air on the apparent salinity of the STD already shunted with another shunt in air. Comparisons were then made on the tabular data from the first fifth of the stations and an empirical correction of +0.3 o/oo was applied to the theoretical equation. This seems reasonable because the wire passing through the core of the cell occupies a fraction of the cross-section and leads to low results in water. A calculation of the resulting area reduction agrees approximately with the empirical correction. However, there has been no opportunity to check this conclusion with the aid of the plots from all the stations.

D. RESULTS

A computer-generated station plan (with a simplified coastline) is shown in Fig. 29. The connecting lines are shown as a visual aid; the actual ship track was considerably more erratic, as may be seen in Fig. 30. The crosses indicate the ship's position at 0100Z and 1300Z. The ship track was used for a diagram of surface temperatures, Fig. 31, which were measured approximately hourly. To a considerable extent the 0°C isotherm marks the ice boundary except that in the coastal current the surface temperature may be warmer in the presence of 1-2 oktas of ice. Elsewhere it could be 0°C in the absence of ice if the relative motion of ice and water were causing water and ice to separate or if ice in low concentrations were drifting through. This latter seems not to have been a frequent occurrence. Ice concentrations derived mainly from observations on station are shown in Fig. 32. Two ice reports are added to give some idea of temporal changes.

Several things about this year's data are notably different than last year.

Warm water, up to 10°C, was found near 167° W well south of the ice. When this water meets the ice, the warm layer seems to be nearly destroyed within a short distance beyond the interface. We seek to demonstrate this and find the dividing line between this kind of behavior and the more strongly sustained warmth typical of the coastal current.

Much less mesoscale structure is present far to the west.

Relict water or water not far from this state seems to fill the bottom of the Chukchi.

The first task is to show how the coastal current compares with last year. Station 86 (Fig. 33) with a surface temperature of 6.0°C is remarkably similar to Station 46 of 1971 but is about 0.4°C colder. If the slight surficial cooling were not present, it would be nearly identical in temperature, layer depth and salinity. Station 19 (Fig. 34) farther south but nearer to shore, is much cooler except for a thin skin near the surface which gets up to 7° C. Station 87 (Fig. 35) is much like Station 86, but is slightly warmer, 6.8°C. The anchorage at Pt. Barrow was different. There the temperature in 1971 was 5.3° C subsurface and 2.8° C on the surface because of the continual passage of drifting ice. In 1972, free of ice, the temperature throughout 18 meters of depth was 7.9°C.

Station 76 (Fig. 36) which corresponds roughly with Station 138 of 1971 is only about 8 miles inside the ice margin, one fourth as far as

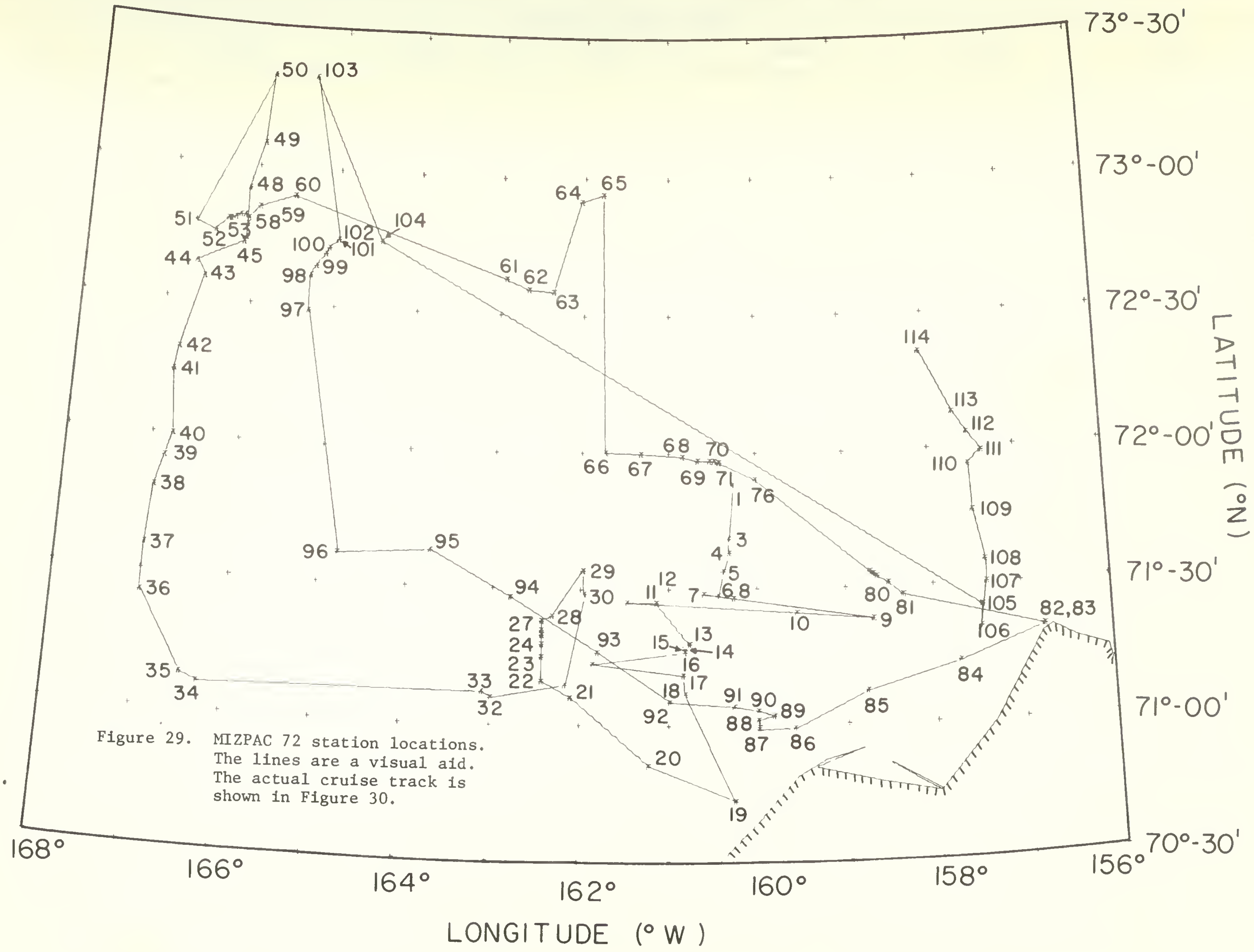

Figure 29. MIZPAC 72 station locations. The lines are a visual aid. The actual cruise track is shown in Figure 30.

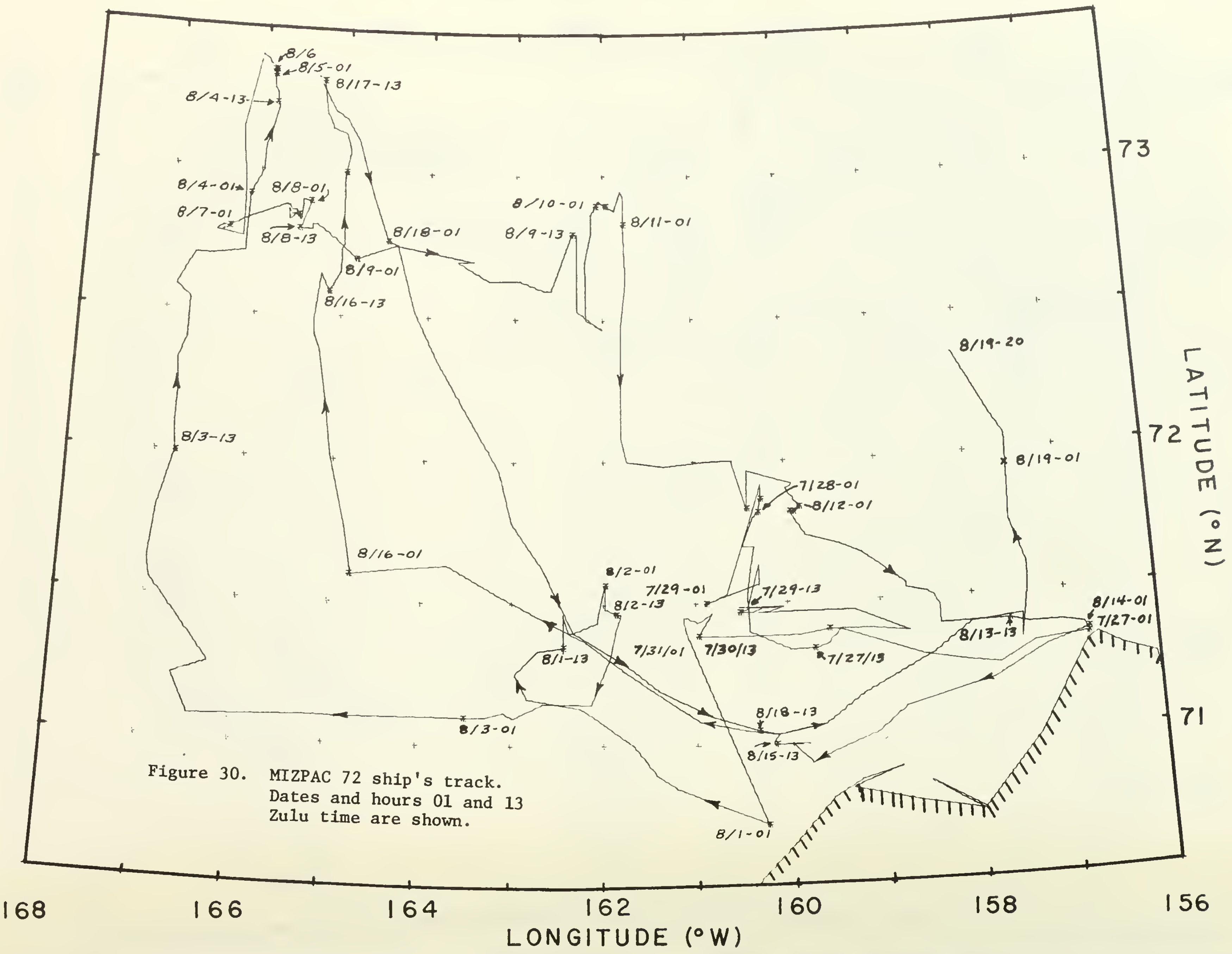

Figure 30. MIZPAC 72 ship's track. Dates and hours 01 and 13 Zulu time are shown.

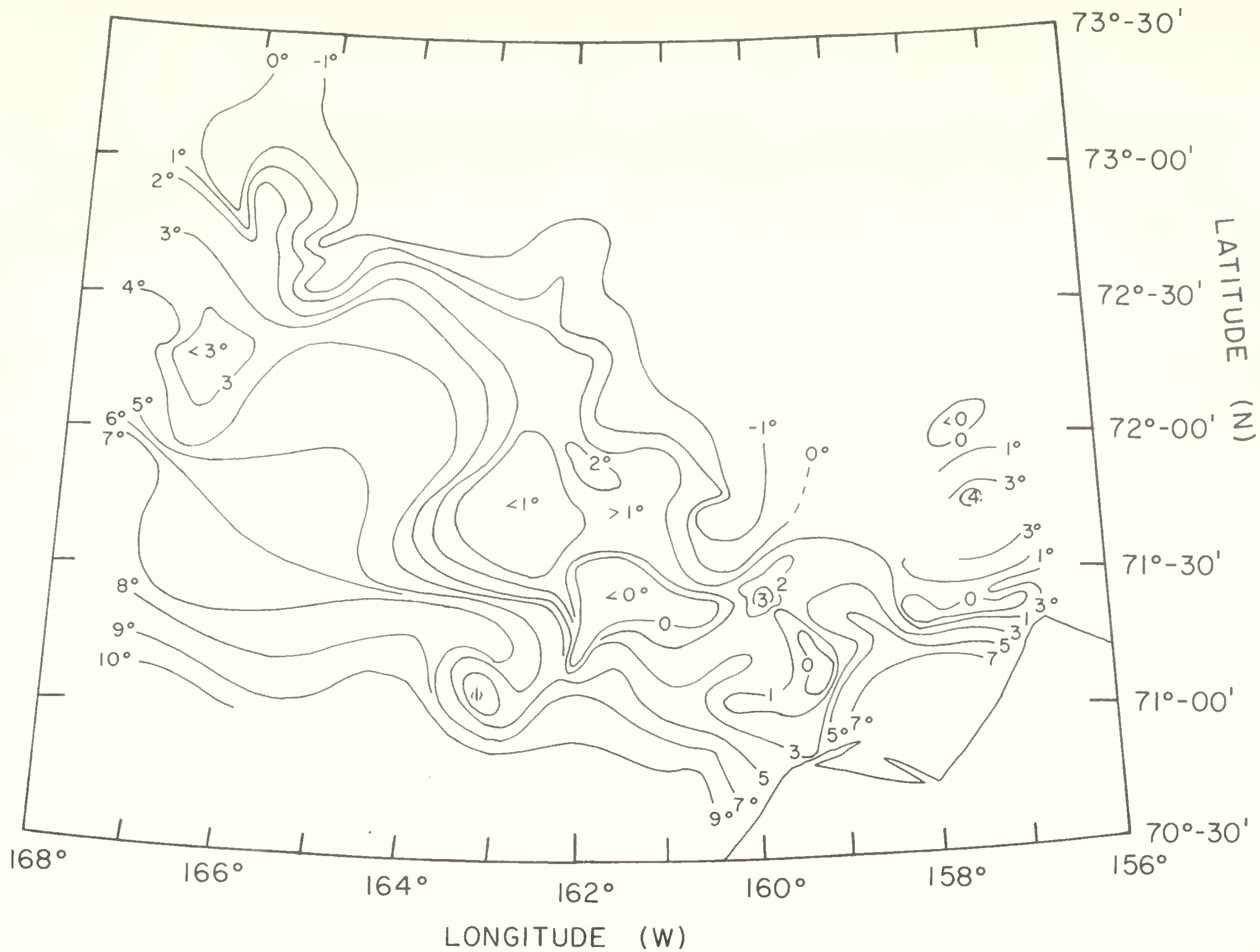

Figure 31. MIZPAC 72 surface temperatures.

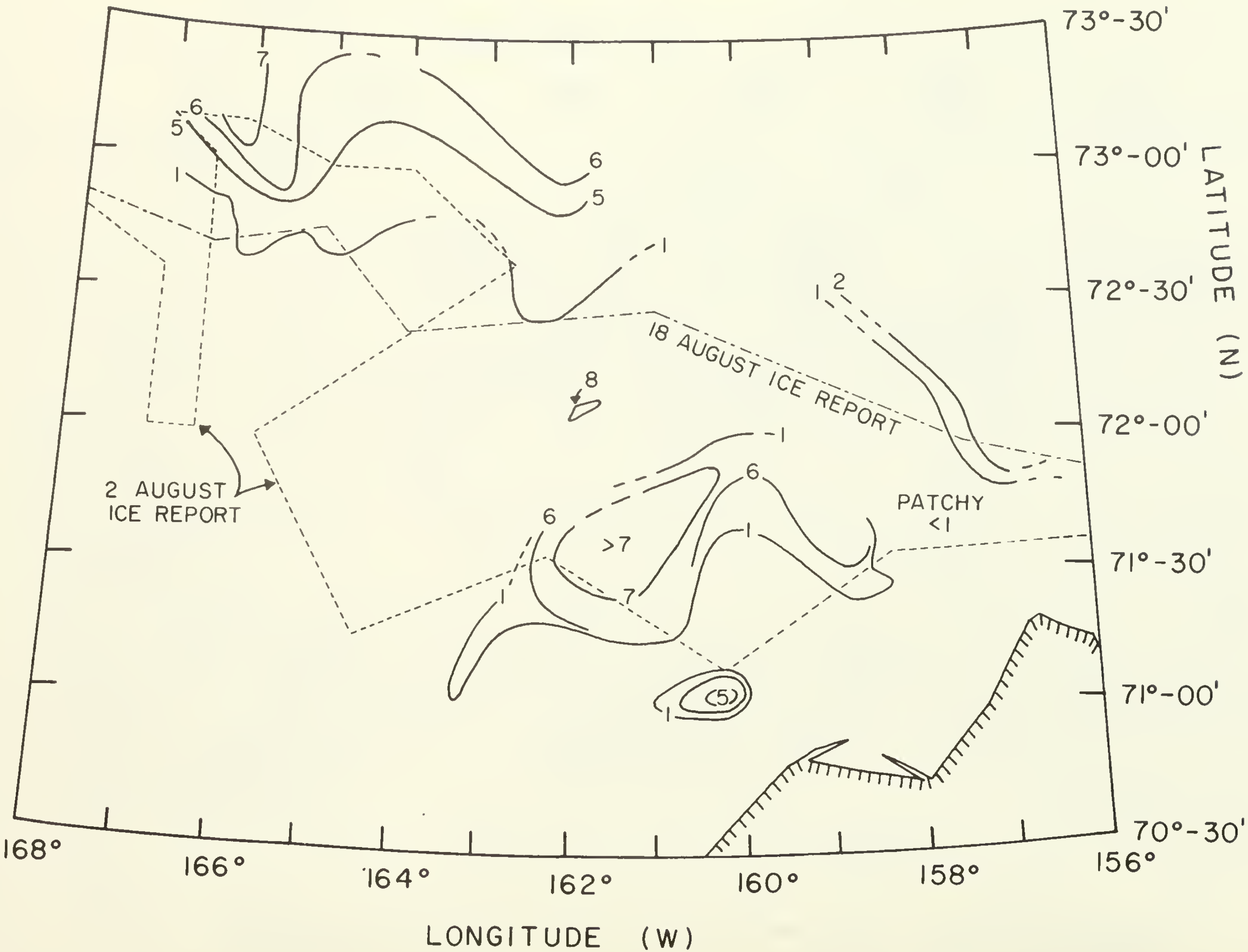

Figure 32. Ice concentration (oktas) from observations on station. Two Naval Weather Service ice reports also are shown.

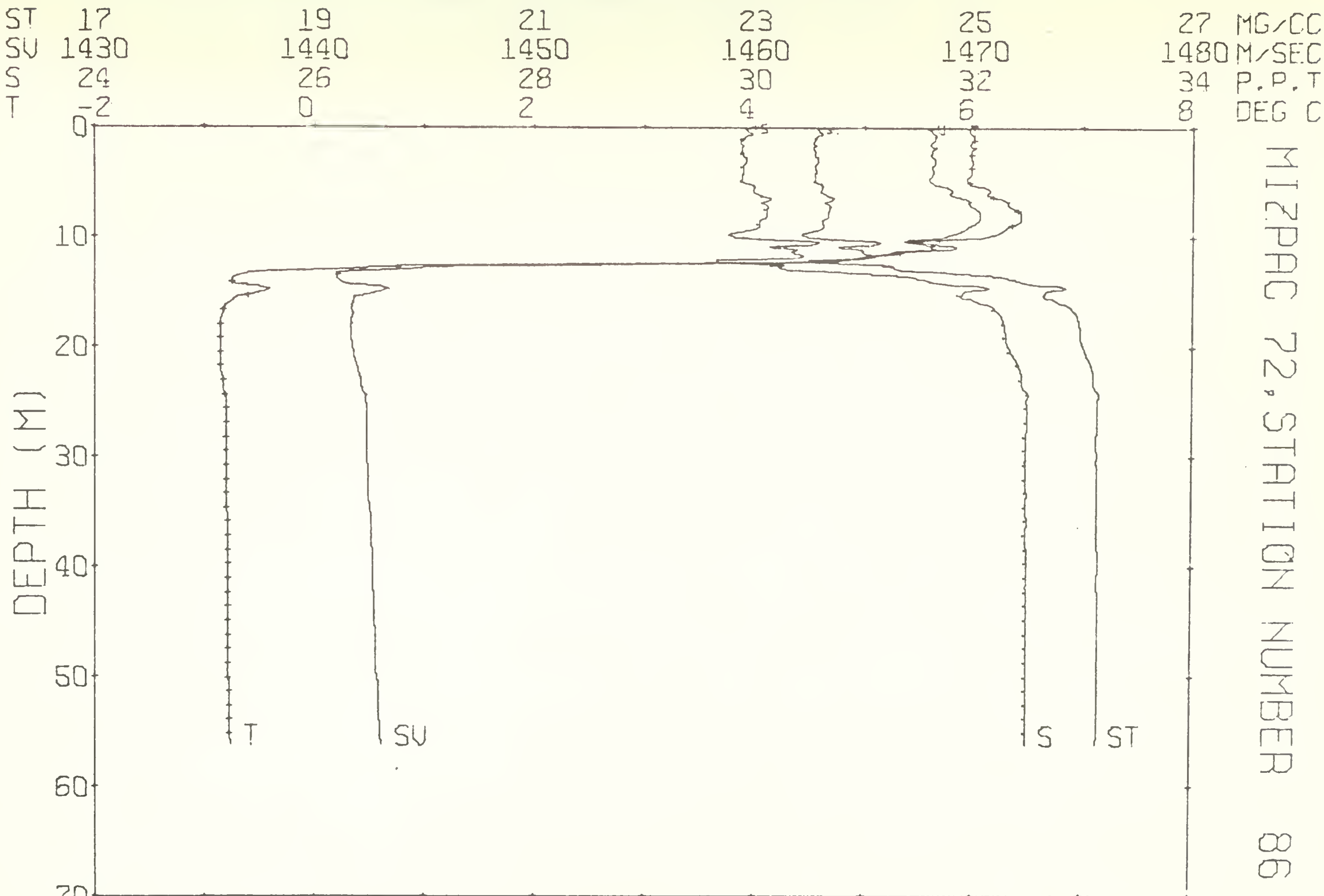

Figure 33. Station 86 property profiles.

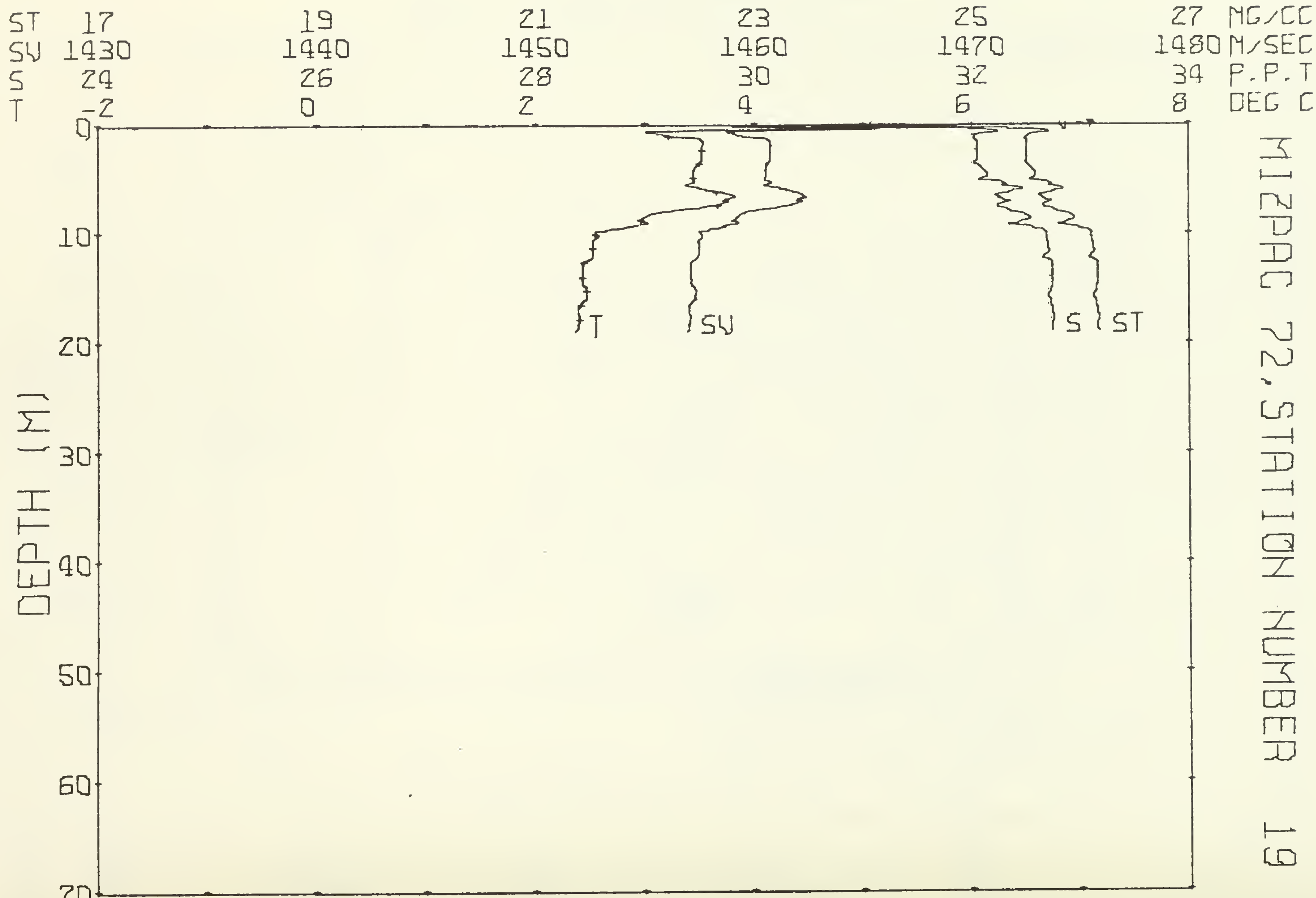

Figure 34. Station 19 property profiles.

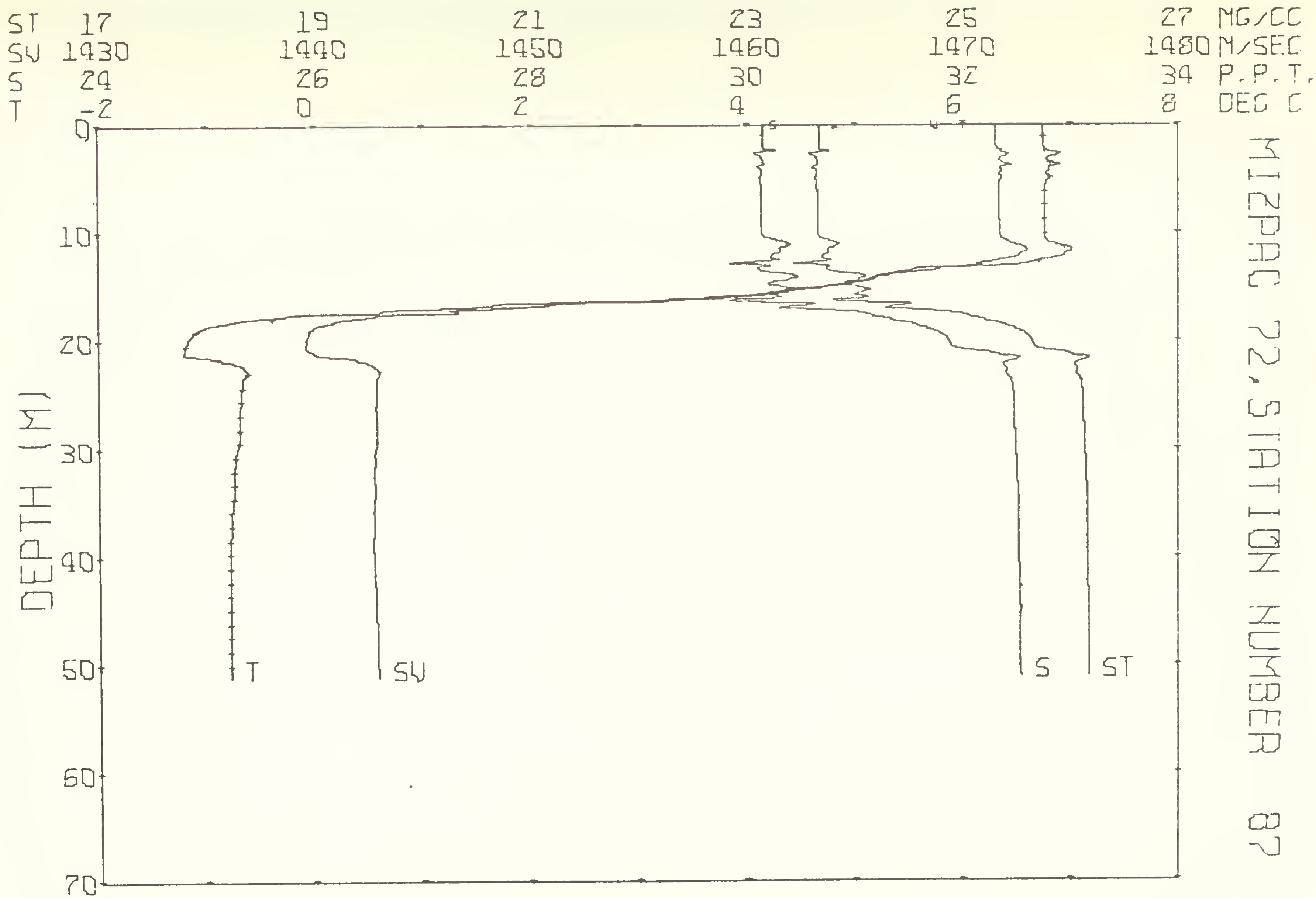

Figure 35. Station 87 property profiles.

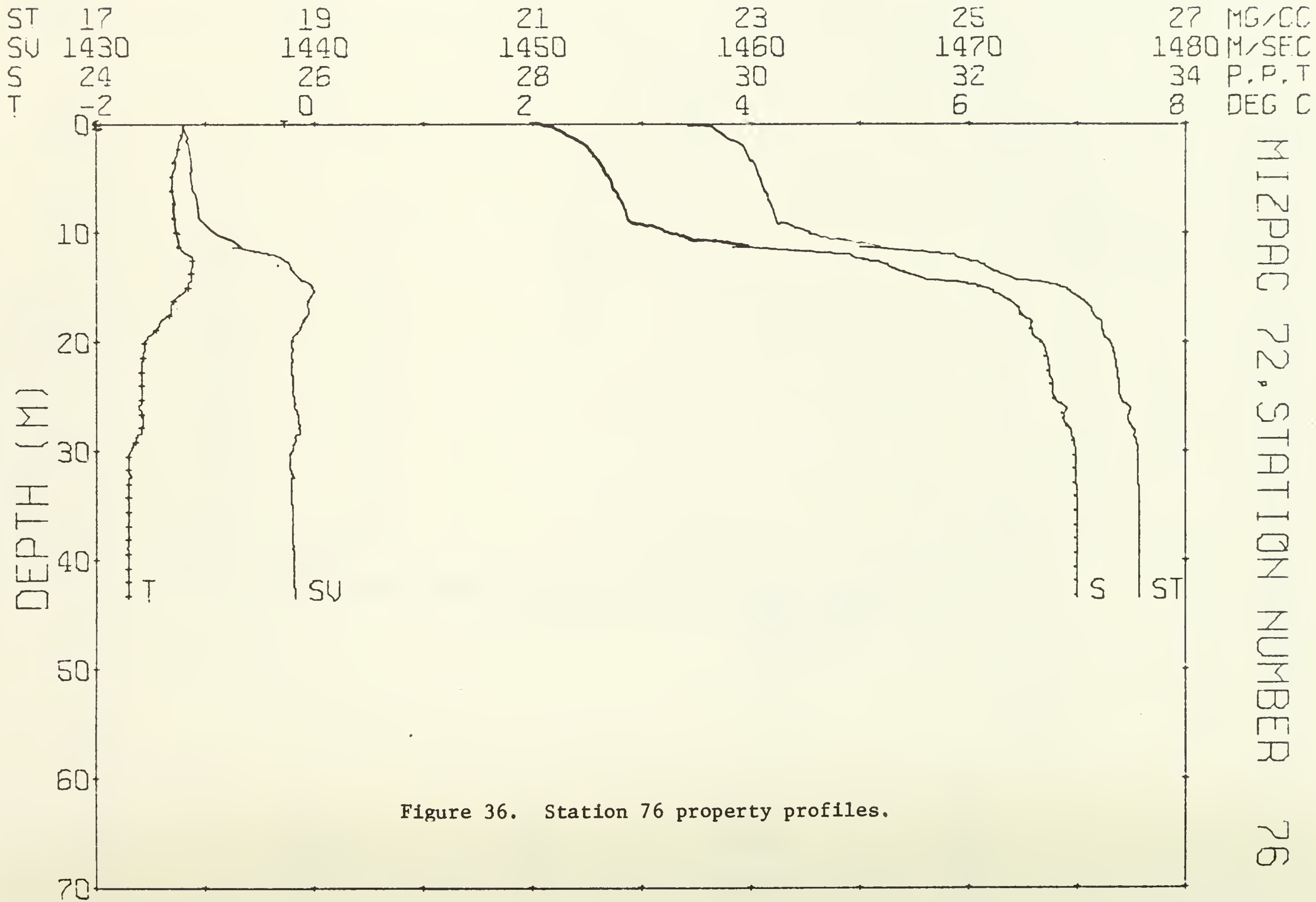

Figure 36. Station 76 property profiles.

in 1971, and is not greatly different than in 1971. The deep temperatures are almost identical, -1.7^{o}C. In 1972 the near bottom salinity is 33.00 o/oo, about 0.3 o/oo lower than in 1971. The surface salinity is about 2 o/oo lower and the residual warm nose is less prominant.

There is some tendency to be misled in making comparisons with 1971 because the 1972 survey covered so much larger an area and is charted on smaller scale. In 1972 most of the stations in and near ice were farther west and north than those in 1971. Most of them, then, are not in the main core of the coastal current, which was found flowing close to the coast. Perhaps the best group to examine for similarities is the sequence 106, 105, 107-114 (Fig. 37). The sequence 106-110 is roughly comparable to the group 75-91 of 1971 with the difference that ice is lacking up to Station 110, except for scattered large isolated floes up to 1000 m in diameter at an over-all concentration less than one okta. During the travel northward there was ice to the west at some unknown distance usually greater than 5 miles. The number of miles inside the margin therefore is shown as "-10?" for the stations concerned. Just beyond Station 110 the ice concentration became about one okta. Even at Station 113 the ship was subjected to a little swell apparently arising from fairly open water to the east. At Station 114 the ice concentration was up to two oktas.

The entire region from Station 107 to 114 was one exhibiting symptoms of large-scale break-up. The warm nose in the temperature profile was present even as far north as Station 114, nearly 50 miles farther north than the point of presumed eastward turning of the coastal current into the Beaufort. This may be because it was a year of greater melting than in 1971 or, conversely, the melting may have been a symptom of greater northward transport of heat which might push the turning point farther north. Still another possibility is that Brower's (1942) observation that the coastal current branches at a point north of Pt. Barrow has some validity and we are observing the northerly (or northwesterly) branch.

The remainder of the survey area, outside the coastal current was characterized by conditions similar to the coastal current as long as the position was well outside the ice. The typical structure was a warm layer, perhaps as warm as 10^{o}C, often isothermal extending to an exceedingly sharp thermocline which then rounded off to a constant temperature of -1.65 to -1.75^{o}C at depths greater than 20-40 mi. In the most westerly portions of the area, cooling at the surface progressed steadily on approach to the ice even though there was little or no ice present south of the ice margin. This situation is summarized in Fig. 38 which nests the temperature plots from Stations 34-44 with a 1^{o}C spacing, stopping just short of the ice. It is interesting that the typical stair-step

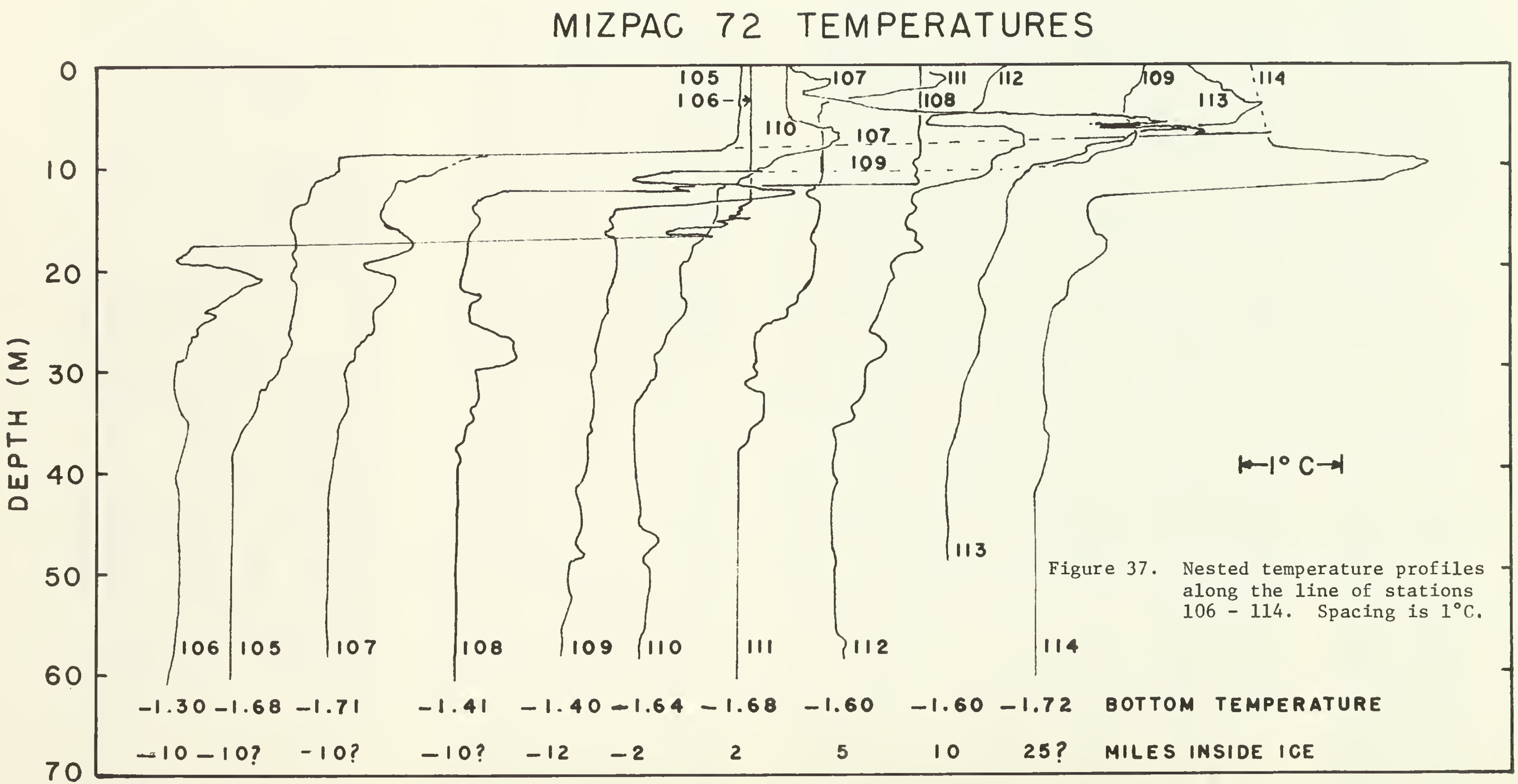

Figure 37. Nested temperature profiles along the line of stations 106 - 114. Spacing is 1°C.

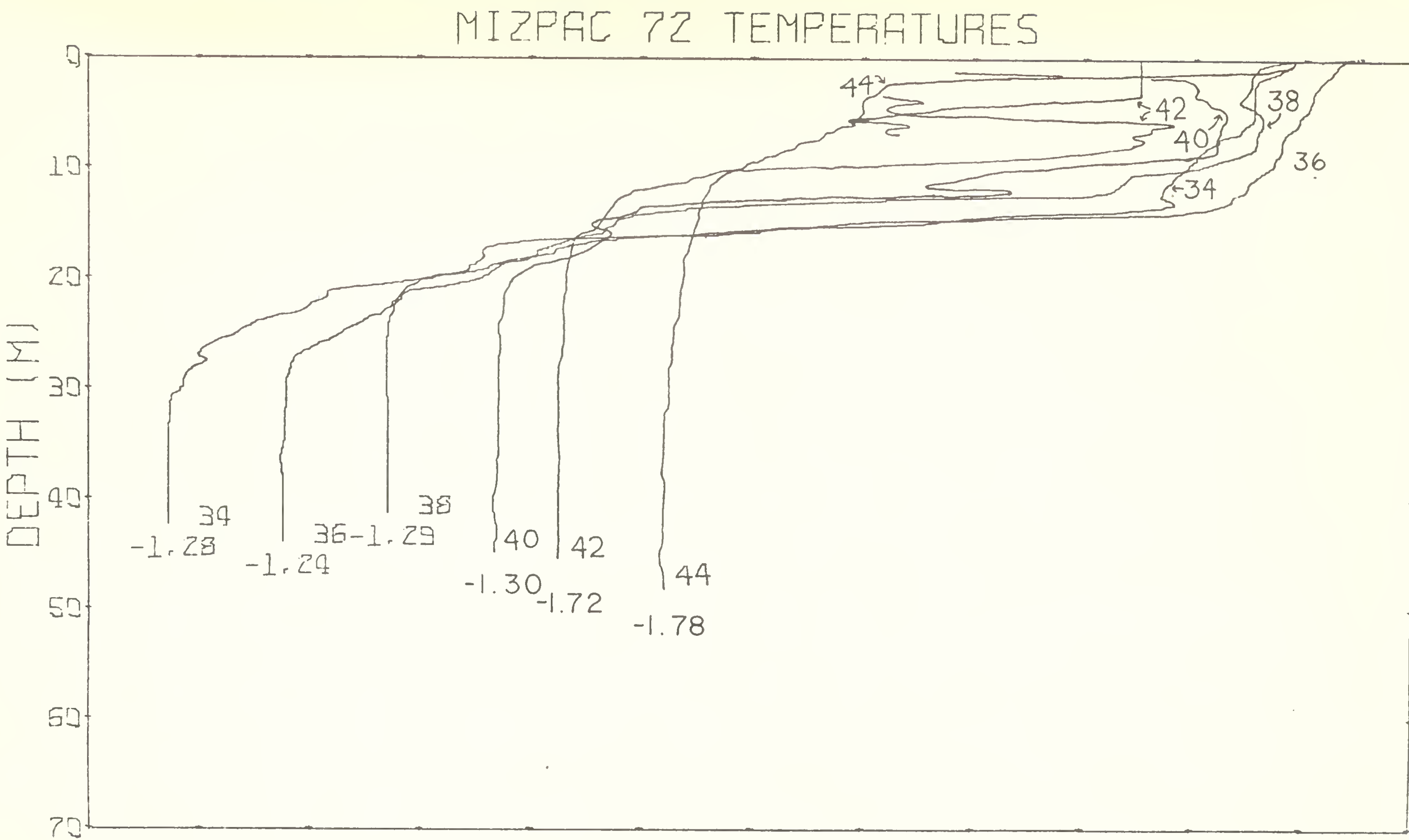

Figure 38. Nested temperature profiles, Stations 34-44. Spacing is 1°C.

structure maintains itself but the warm layer thins as cooling progresses. Wave action accounts for the mixing of the upper layer; thinning of the upper layer appears to be due to thickening of the sub-thermocline layer rather than to mixing of heat downward. Geostrophic forces associated with an easterly current component could cause this condition. We picture here the possible existence of a cyclonic gyre in the northern Chukchi as suggested by Aagard and Coachman (1964) and by the ice drifts reported by Garrison and Pence (1973).

The cooling toward the north could be due to a loss of heat to the atmosphere or to the presence of diffuse ice in the recent past. In this connection note the long tongue of ice extending south along this line of stations according to the ice report of August 2, one day earlier, as shown in Fig. 32. One might also consider it possible that the flow is toward the south or southeast and that warming takes place as the water drifts southward. This must not be true or the ice would drift southward in the presence of the predominantly westerly winds prevailing at the time (See Appendix I for wind data).

Figure 39 continues this series of Fig. 38 across the ice interface. At Station 47, 3 miles inside the ice margin, most of the near-surface warmth was gone. However, it is interesting that all the profiles of this series, even to 18 miles inside the margin,were warmest at the surface. There was little mesostructure.

Another crossing in the same area is shown in Fig. 40. The conclusion is similar but, at and just within the ice boundary, cooling at the surface was sufficient to produce a small "warm" nose. The series of Stations 66 to 74, Fig. 41, another crossing of the ice margin in the east-central part of the area, lead to similar conclusions.

The sequence of Stations 22-28, Fig. 42, 65 miles from the coast is somewhat similar. The warm nose maintains itself a little better, there is structure in the depth zone which was warm, but not much warmth was retained at the 5-mile penetration, Station 28.

In the coastal current, the picture which developed in 1971 was one in which the warm layer maintained itself with little temperature decrease until it encountered ice. Then the remanants of the layer were still maintained at depth after many miles of travel under the ice. Mesostructure was frequent and sometimes prominent. The series, Station 106-114, already illustrated, also adheres to this type.

The difference in the westerly stations may most easily be accounted for by a difference in the rate of flow of the warm water. West of the coastal current one sees a layer of warm Bering Sea water

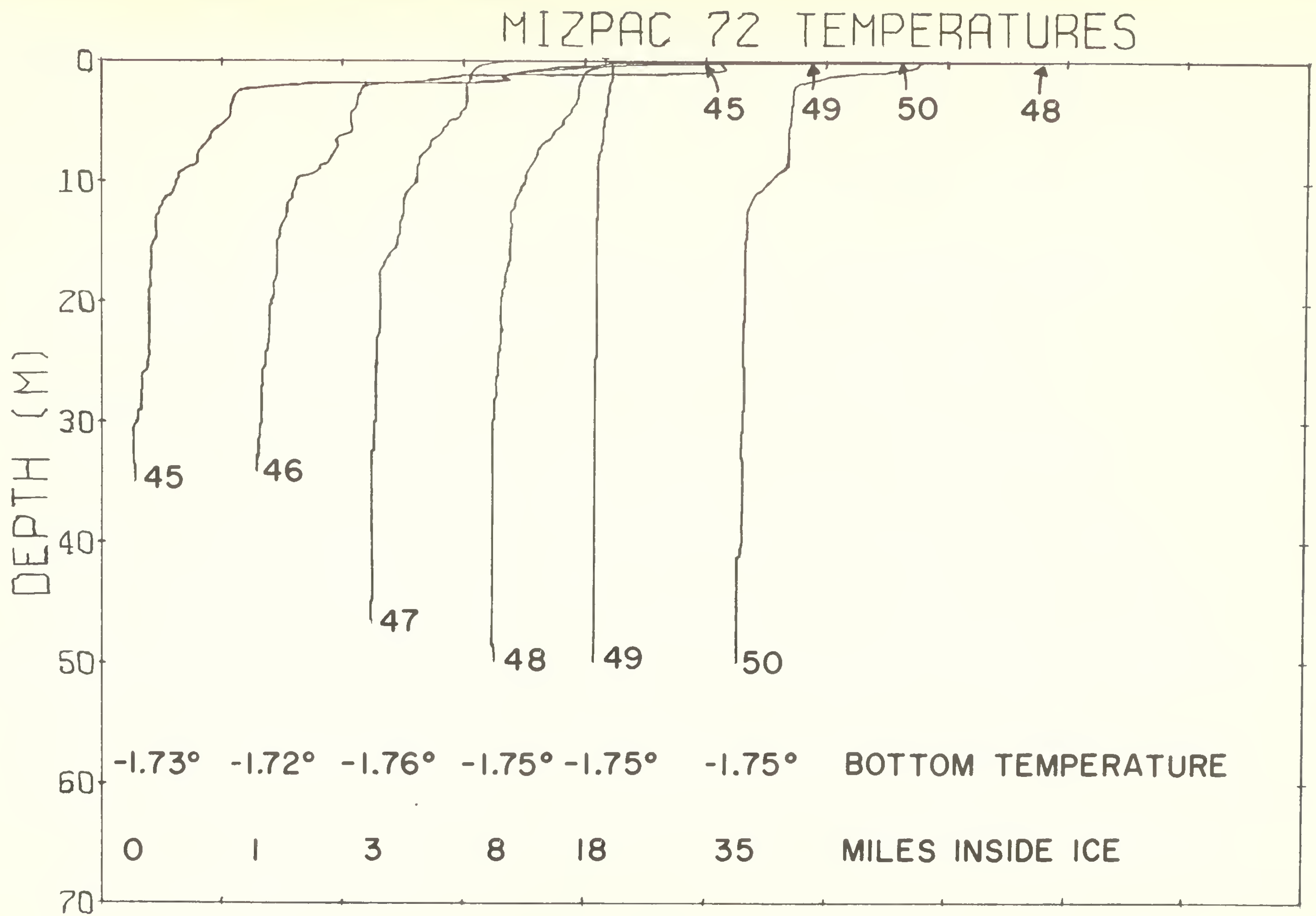

Figure 39. Nested temperature profiles, Stations 45-50. Spacing is 1°C.

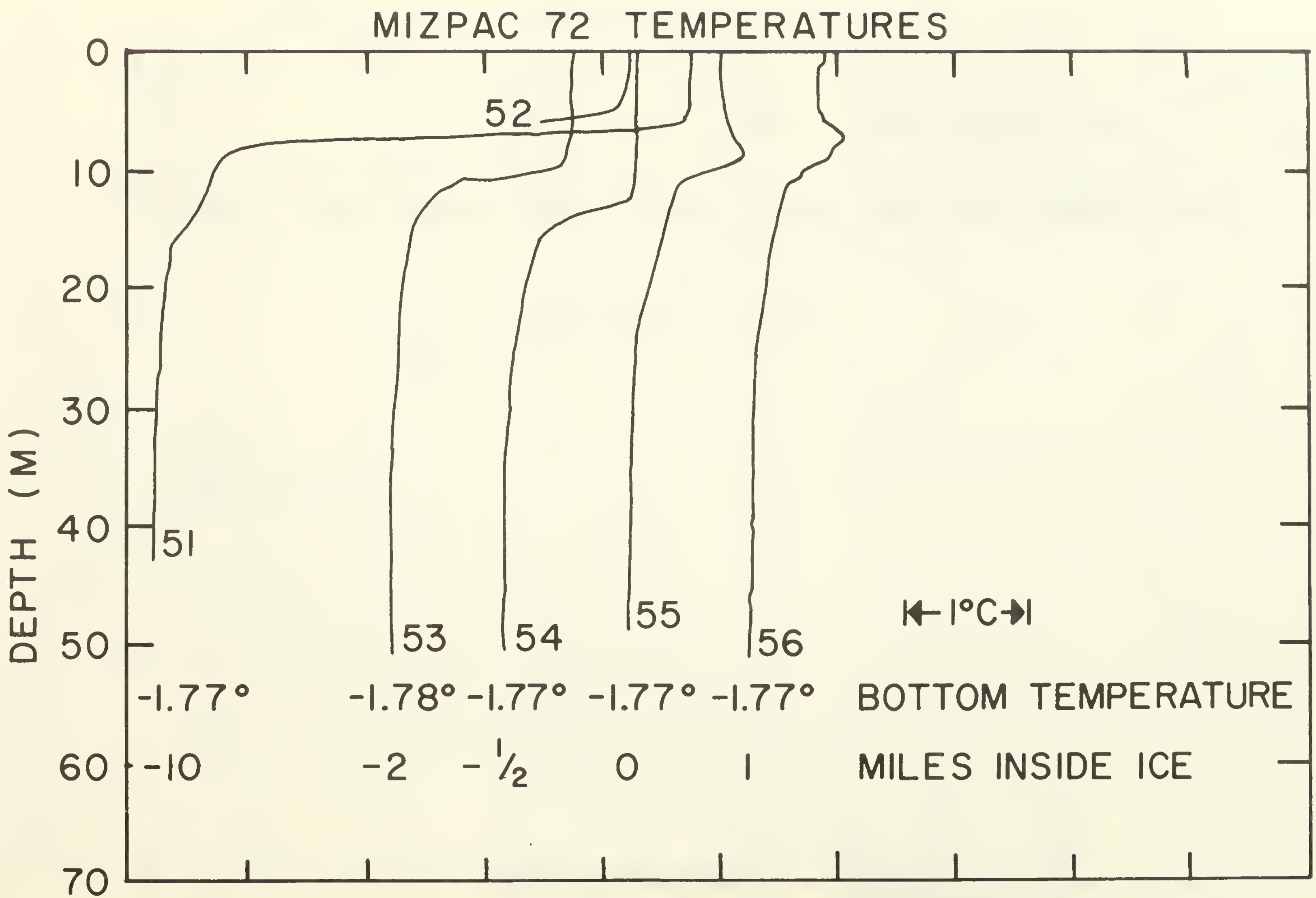

Figure 40. Nested temperature profiles, Stations 51-56. Spacing is 1°C.

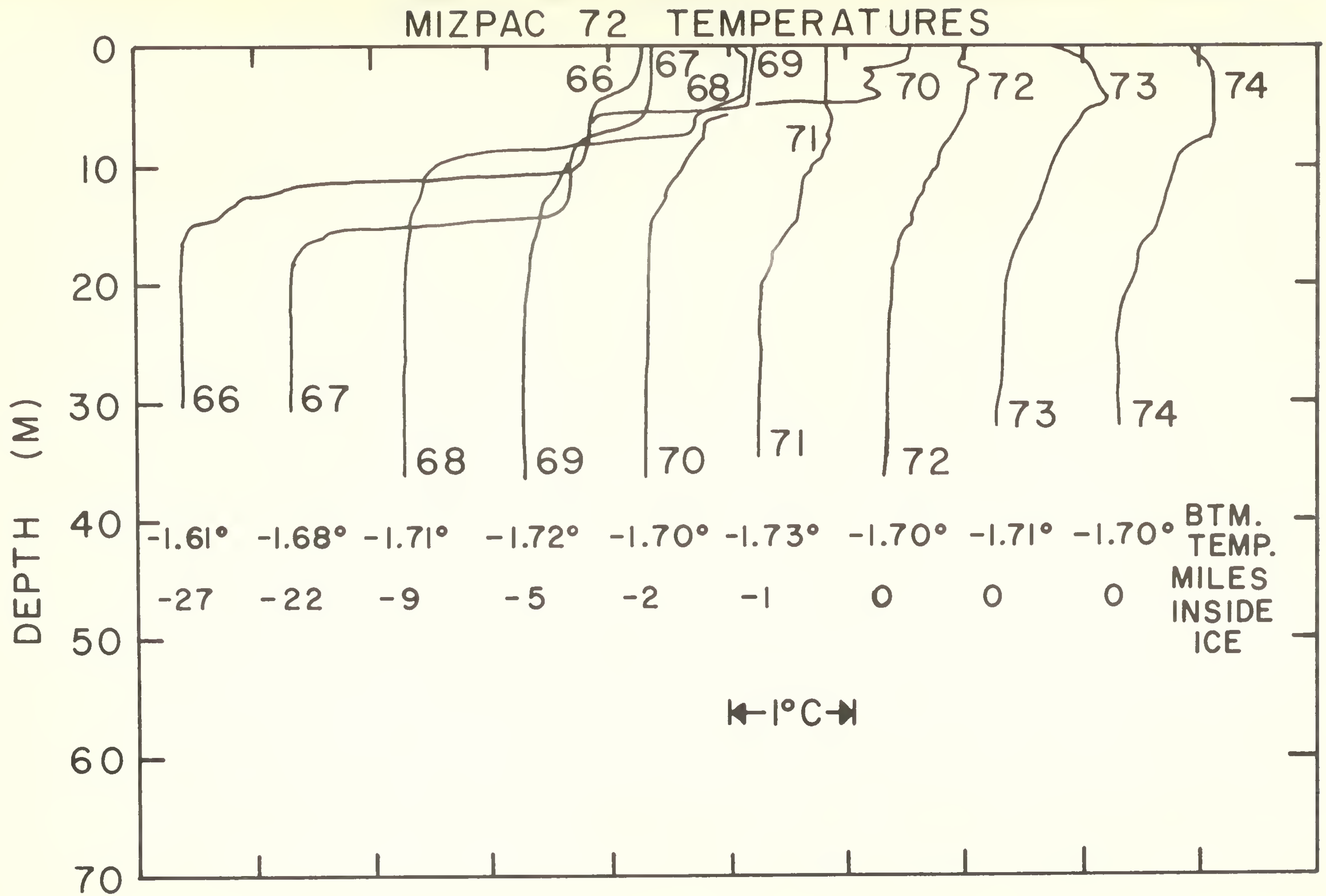

Figure 41. Nested temperature profiles, Stations 66-74. Spacing is 1°C.

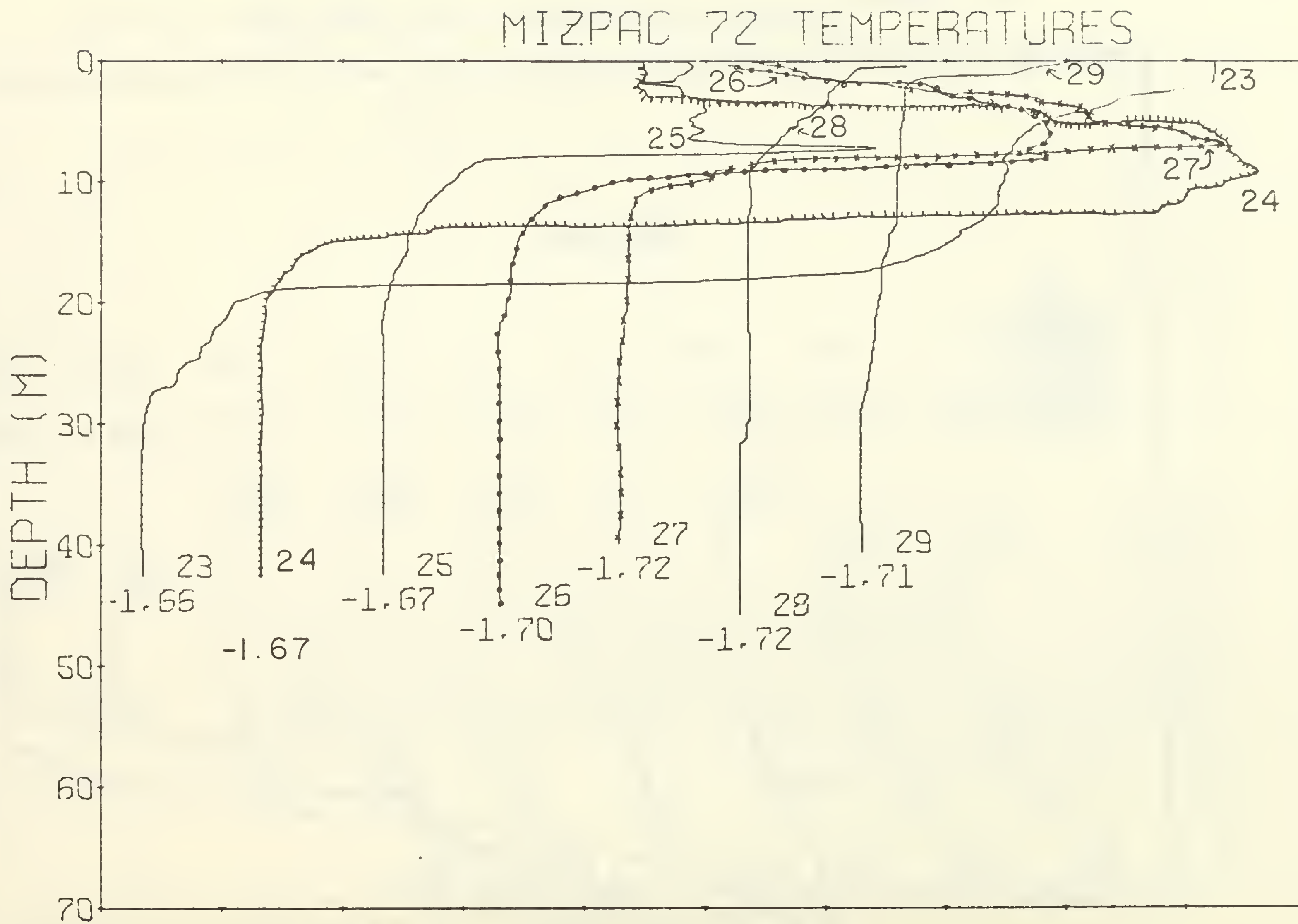

Figure 42. Nested temperature profiles, Stations 23-29. Spacing is 1°C.

with about the same thickness and temperature as that which supplies the coastal current. But it must flow more slowly, so it cools in a shorter distance along its path, either by loss of heat to the atmosphere or because of a sporadic macro-diffusion of ice southward. The local density differences which result when large quantities of ice are being melted at different but rapid rates are now much smaller and interleaving of waters of different temperatures is a languid rather than a violent process. Hence little mesostructure results.

One should not postulate that conditions still farther to the west need be similar. The average ice conditions for late August (U. W. Naval Oceanographic Office, 1958) show a deep lobe of melting with its axis directed toward Wrangel Island. Our most westerly station is on the eastern margin of this lobe. The size of the lobe suggests that the melting occurring there is more extensive and perhaps as intensive as along the Alaskan coast. Hence, the water flow may be similar to those near the coastal current.

E. CONCLUSIONS

In 1972 the area surveyed was mostly well to the west of the coastal current. However, enough stations were in locations similar to those of 1971 to support the conclusion that the coastal current was like it was in 1971, possibly a little warmer. Perhaps the higher temperatures were due to the ice being farther north rather than to any change in temperature at the source in Bering Strait.

The entire area south of the ice and westward to 167° W, which is 140-190 miles from shore, was found to contain warm water, as warm as 10° C, in a layer up to 20 m thick riding on what is apparently a layer of relict water formed during the winter. This is similar to conditions near the coast, though somewhat warmer, but the deep layer is now colder than -1.65°C with few exceptions. The interface between the two layers is sharp but there is often a rounding of the temperature trace before the deep isothermal layer is reached. There appears to be no gap between the warm water in the coastal current and the warm water seaward. Thus, the splitting of the northward-flowing water at Pt. Hope which is mentioned by Aagard and Coachman (1964) does not seem to result in a complete separation of the two branches.

Well away from the coastal current the phenomena associated with interaction of warm water and ice are mild. Most of the warm layer is usually gone within about one to three miles inside the ice margin, leaving a residual slightly warmer nose at between 5 and 10 m depth. Indeed, cooling of the warm layer toward the north occurred even in the absence of ice. Mesoscale structure in the temperature

profiles is mild or absent in this region. When it does occur, it tends to be in the depth zone of the warm layer and not in the layer below the thermocline.

At a distance of 65 miles from the coast, intermediate conditions occurred in the sense that the warm layer seemed better able to maintain itself up to and beyond the ice boundary. There was more mesostructure but it did not penetrate below the depth of the original warm layer.

The milder nature of the phenomena in the region seaward of the coastal current may be ascribed to a much weaker flow of warm water toward the ice.

IV. GENERAL CONCLUSIONS

1. The eastern Chukchi Sea, as observed north of 70° N and west to 167° W, is influenced by warm water flowing north from Bering Strait. The warm water typically lies in a layer 10-20 m thick atop a cold layer which, in much of the area, appears to be a relic of last winter's freezing processes. The region within 30-50 miles of the Alaskan coast behaves differently than the rest of the area because the water near the coast is flowing rpaidly north-eastward. As a result, the interactions with the ice are more productive of complex temperature and sound-velocity profiles and residues of the warm water intrude farther under the ice than in the region far from shore.

2. Near the coast, the result of warm water meeting ice is surficial cooling and a formation of a warm nose in the temperature profile, just beneath the surface. Mesoscale temperature inversions and irregularities complicate the profiles both above and below the thermocline. West of the coastal zone similar but less marked phenomena occur. Most of the heat is gone within a few miles under the ice, sometimes even before the ice boundary is reached. Mesostructure generally is mild and is confined to the region near the ice margin and above the thermocline.

3. The warm layer near the coast gradually descends as it moves toward the Arctic Basin. There, at least a portion of the warm water turned east and flows into the Beaufort Sea to at least 147°W. The core of the warm water is at a depth of 25-50 m and is mostly seaward of the 10-fathom curve. In this region it does not interact with ice directly and the mesostructure consequently is mild. The temperature profile typically has a bulge to as much as 4° at the depth of the warm core.

4. In 1972, phenomena in the coastal current appeared to be similar to 1971 but the ice was much farther to the north. Temperature structures typical of rapid flow were found northwest of Pt. Barrow 50 miles farther seaward than the point at which the current had been presumed to turn to the east in 1971. This may be a seasonal difference or may indicate a branching in the current.

V. ACKNOWLEDGMENTS

The authors are indebted to the officers and crews of USCGC NORTHWIND and BURTON ISLAND. Assisting with observations in 1971 were Dr. M. Allan Beal of the Naval Undersea Center, San Diego, Mr. Ernest Linger of the Applied Physics Laboratory, University of Washington and U. S. Coast Guard Cadets J. F. McEntire, G. H. Detweiler and B. V. Hunter. Also assisting were Marine Science Technicians Brown, Tate and Thompson and Marine Science Chief Meehan. In 1972, those assisting with observations were Peter Benson and Richard Bachman of NUC, Marine Science Technicians D. A. Frappier, J. H. Doing, R. N. Green, W. R. Shepard and Toscano and MSC F. E. Wiggins.

In 1971 the STD was supplied in excellent condition by the U. S. Naval Oceanographic Office and the remaining ancillary electronic equipment and a laboratory salinometer were supplied by Delco Electronics, Santa Barbara Operations. In 1972 the STD was supplied by the Arctic Submarine Laboratory of NUC and the ancillary equipment, as before, by Delco Electronics.

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APPENDIX I

CODING OF THE HEADINGS AND MAGNETIC TAPE FORMATS

The headings of both printed and magnetic-tape outputs use the coding and format from NODC Publication M-2, August 1964, with a few exceptions. The heading entries which are not self-explanatory are as follows. MSQ is the Marsden Square, water depth is in meters, wave source direction is in tens of degrees, but the direction 00 indicates no observation. The significant height is coded by Table 10 (Code/2 $\cong$ height in meters). Wave period is coded by Table II (Code x 2 $\cong$ period in sec). Wind speed is coded as Beaufort force, Table 17. The barometer is in millibars, less 1000 if more than 3 digits; dry-bulb and wet-bulb temperatures are in degrees C, coded with a minus sign rather than an overpunch. The cloud type is from Table 25 and amount (oktas) from Table 26, with X in the first case and 9 in the second case indicating that clouds cannot be observed because of environmental conditions. The visibility is from Table 27 which is roughly in powers of two with Code 4 = 1 - 2 km. The ice concentration is in oktas.

The entry CODE indicates the kind of data taken on the station as follows:

1. STD in entire water column sampled.

2. STD in lower part of water column, no data from upper part.

3. STD and shunted STD used; two lowerings.

4. STD and Beckman RS5.

5. Beckman RS5 only.

6. 1971 only, Sta. 92-103, conductivity cell shunt inconveniently low resistance. Sta. 104-163, shunted STD only.

Codes 7 to C (hexadecimal). Same as above, but without surface bucket observation. Codes 4, 5, 6, A, B, and C were not applicable in 1972.

The magnetic tape output was written on 9-track tape in 40-digit records blocked to 3200 digits at density 400 bpi. Each set of station data is preceded by heading information occupying two 40-digit records, nearly equivalent to the NODC header card. The water properties are in the order depth, temperature, salinity, sound velocity (meters/sec), and sigma-t in Fortran format 3F6.2, F8.2, F7.3. In 1972 the format is

F6.2, 2F6.3, F7.2, F7.4; in 1972 the stations are listed in several files, presently only partly in serial order.

The heading is formatted as follows:

Columns	
1-2	Nation code
3-4	Ship code
5-9	Latitude, degrees and tenths
10-15	Longitude
16-18	Marsden square
19-20	Year
21-22	Month
23-24	Day
25-27	Hour (Greenwich) and tenths, start of lowerings
28-30	Cruise No. (blank)
31-33	Station No.
34-37	Bottom depth, meters (called DPTH on header listings)
38-39	Depth at which STD starts, meters (called SDPTH on header listing)
40	Blank

Forty is added to the column number of the second record below to make comparison with NODC format simpler.

Columns	
41-43	No.of sets of observations in the tabulation as inserted by header card (on tape but not on header card in 1976)
44	CODE
45	Zero or blank in 1971. In 1972, a minus sign converts the following ice concentration digit, I, to the sense of 10 exp(-I).
46	Ice concentration in oktas (labeled IC on header listing)
47-48	Wave direction (WVD on header listing)
49	Wave height code
50	Wave period code
51-52	Wind direction (WND on header listing)
53	Blank
54	Wind speed, Beaufort (V)
55-57	Barometer, millibars less the thousands digit
58-60	Air temperature and tenths (with minus sign, no over-punches). Labeled DRY on header listing
61-63	Wet-bulb temperature as above (WET on header listing)
64	Blank
65	Weather code (WTHR)

Column	
66	Cloud type code (CL)
67	Cloud amount code
68	Visibility code
69	SORD, puts in the "S" or "D" for the Station No. (not used in 1971)
70-72	Number of observations as counted by Program MIZ1 (on tape but not on header cards in 1972)
73-75	Station number as produced by MIZ1

(Note that these last two are redundant and were used for checking)

76-80	Blank

APPENDIX II

HEADING DATA FOR STATION OCCUPIED IN 1971 AND 1972

Heading data are listed on the following pages for 1971 and 1972. The coding conventions are those described in Appendix I.

MIZPAC 71 STATICN FEACINGS

NAT	SHIP	LAT	LONG	MSQ	MO	DY	YR	HR	STA	DPTH	SDPTH	CBS	COD	IC	WVD	HT	PER	WND	V	BAR	DRY	WET	WTHR	CL	AMT
31	NW	71-31.	159-42.	268	07	30	71	01.0	1	54	00	11	3			0					.	.			
31	NW	71-30.	159-43.5	268	07	31	71	19.6	3	48	00	123	7	7							.	.			
31	7W	71-3C.	159-43.5	268	07	31	71	22.5	4	48	03	143	7	7		0				010	1.3	1.0	1	5	7
31	NW	71-3C.	159-43.5	268	08	01	71	00.0	5	48	01	125	7	7		0				01C	.	.	1		
31	NW	71-30.	159-43.5	268	08	01	71	04.5	6	48	07	127	7	9		0				010	.8	1.1	1	5	6
31	NW	71-31.5	160-05.	26	08	01	71	18.5	7	47	10	146	A	6		0		23	3	008	1.5	1.C	2	6	8
31	NW	71-31.5	160-05.	26	08	01	71	21.3	8	47	09	123	8	6		C		23	3	007	2.2	1.8	1	6	7
31	NW	71-31.5	160-05.	269	08	01	71	23.5	9	47	10	125	4	6		0		23	3	006	1.8	1.8	2	7	8
31	NW	71-31.5	160-05.	269	08	02	71	02.8	10	47	08	127	8	7		0		25	3	017	1.5	1.C	2	6	8
31	NW	71-31.5	160-05.	269	08	02	71	04.5	11	47	09	127	A	7		0		25	0		1.5	1.0	2	6	8
31	NW	71-31.5	160-C5.	269	08	02	71	04.5	11	47	09	127	A	7		0		25	0		1.5	1.C	2	6	8
31	NW	71-31.5	160-C5.	269	08	02	71	07.0	12	48	09	128	A	6		0		23	3	007	1.1	C.8	7	7	
31	NW	71-32.	160-05.	269	08	02	71	08.5	13	48	10	126	A			0					.	.			
31	NW	71-32.	160-05.	269	08	02	71	10.8	14	48	10	129	A			0		24	3	007	.	.	4	X	9
31	NW	71-32.	160-05.	269	08	02	71	12.8	15	48	11	135	A			0					.	.	2	7	8
31	NW	71-32.	16C-C5.	269	08	02	71	14.9	16	48	09	121	A	6		0		24	3		.	.	7	7	8
31	NW	71-3C.	159-56.	268	08	02	71	16.5	17	48	07	127	A	7		0		26	4	006	.	.	7	7	8
31	NW	71-30.	159-56.	268	08	02	71	16.5	17	48	07	127	A	7		0		26	4	006	.	.	7	7	8
31	NW	71-3C.	159-56.	268	08	02	71	18.0	18	48	10	132	A	7		0		26	4	007	.	.	7	7	8
31	NW	71-30.	159-56.	268	08	02	71	19.0	19	48	13	127	A	7		0		26	4	007	.	.	7	7	8

MIZPAC 71 STATION HEADINGS

NAT	SHIP	LAT	LONG	MSQ	MO	DY	YR	HR	STA	DPTH	SDPTH	OBS	COD	IC	WVD	HT	PER	WND	V	BAR	DRY	WET	WTHR	CL	AMT
31	NW	71-30.	159-56.	268	08	02	71	19.0	19	48	13	127	A	7		0		26	4	007	.	.	7	7	8
31	NW	71-3C.	159-56.	268	08	02	71	20.1	20	50	12	127	A	7		0		26	4	007	.	.	7	5	2
31	NW	71-3C.	159-56.	268	08	02	71	20.1	20	50	12	127	A	7		C		26	4	0C7	.	.	7	5	2
31	NW	71-30.	159-56.	268	08	03	71	C0.9	23	5C	10	123	A			0					.	.	2	7	8
31	NW	71-3C.	159-56.	268	08	03	71	03.1	24	50	10	127	A			0		30	4	011	.	.	2	6	8
31	NW	71-30.	159-56.	268	08	03	71	03.1	24	5C	10	127	A			0		30	4	011	.	.	2	6	8
31	NW	71-3C.	159-56.	268	08	03	71	06.0	26	50	10	121	A	6		0		28	4	012	.	.	7	7	6
31	NW	71-30.	159-56.	268	08	03	71	07.0	27	48	11	129	A	6		C				012	.	.	7	7	6
31	NW	71-30.	159-56.	268	08	03	71	C8.0	28	48	11	13C	A	6		0			5	012	.	.			
31	NW	71-3C.	159-56.	268	08	03	71	09.1	29	48	12	126	A	6		0					.	.			
31	NW	71-30.	159-56.	268	08	03	71	10.0	30	48	11	126	A	6		0					.	.			
31	NW	71-3C.	159-56.	268	08	03	71	11.0	31	48	11	128	A	6		0		26	4	012	.	.		7	8
31	NW	71-30.	159-56.	268	08	03	71	12.0	32	48	10	128	A	6		C		26	4	012	.	.	2	7	8
31	NW	71-30.	159-56.	268	08	03	71	13.0	33	48	10	127	A	6		0		26	4	012	.	.	1	7	7
31	NW	71-3C.	159-56.	268	08	03	71	14.5	34	48	11	132	A	6		0				012	.	.	1	7	7
31	NW	71-30.	159-56.	268	08	03	71	15.5	35	48	10	124	A			0					.	.			
31	NW	71-49.4	160-12.8	269	08	04	71	C3.6	40	45		125		0	30	3		31	5	015	.	.	2	7	8
31	NW	71-44.	160-31.	269	08	04	71	05.4	41	40	10	125	4	C	30	3		30	3	015	.	.	2	7	8
31	NW	71-51.	160-47.	269	08	04	71	C7.3	42	45	08	14C	4	C	30	3		31	3	016	.	.	2	7	8
31	NW	7C-46.	161-CC.2	269	C8	04	71	C9.5	43	44	13	123	2	0							.	.			

MIZPAC 71 STATION READINGS

NAT	SHIP	LAT	LONG	MSQ	MO	DY	YR	HR	STA	DPTH	SDPTH	OBS	COD	IC	WVD	HT	PER	WND	V	BAR	DRY	WET	WTHR	CL	AMT
31	NW	70-39.3	162-00.3	269	08	04	71	11.2	44	47	07	125	2	0	28	3		29	5	016	3.3	3.0	2	6	8
31	NW	70-30.	162-37.	269	08	04	71	12.8	45	36	13	108	2	0							.	.			
31	NW	70-20.	163-02.5	269	08	04	71	14.2	46	42	00	97	1	0	28	3		29	5	017	3.3	3.0	2	5	8
31	NW	70-31.9	163-07.	269	08	04	71	15.5	47	48	09	114	2	0	28	3		29	5	017	.	.	2	5	8
31	NW	70-46.	163-03.	269	08	04	71	16.9	48	42	10	122	2	0	28	3		30	4	016	.	.	2	5	8
31	NW	70-51.	162-53.	269	08	04	71	17.8	49	47	10	139	2	4	30	3		30	4	016	2.4	1.9	2	5	8
31	NW	70-57.	162-42.	269	08	04	71	18.6	50	44	04	132	2	2		0		30	3	016	2.3	2.0	2	5	8
31	NW	70-55.	161-57.	269	08	04	71	21.4	52	42	07	124	2	1		0		30	4	015	3.7	26.	6	8	7
31	NW	70-55.	160-30.	269	08	05	71	00.7	54	53	00	141	4	2		0		29	4	014	3.1	2.2	2	6	8
31	NW	70-53.	159-46.	268	08	05	71	02.0	55	49	11	146	2	1		0		26	3	014	2.9	2.9	2	8	8
31	NW	70-56.5	159-41.	268	08	05	71	02.9	56	54	08	126	2	4		0		27	2	014	.	.	2	8	8
31	NW	70-58.4	159-23.	268	08	05	71	04.0	57	60	09	158	2	2		0				014	..	.			
31	NW	70-58.	159-04.	268	08	05	71	05.0	58	33		095	1	2		0		27	2	014	.	.	4	X	9
31	NW	70-59.	158-31.	268	08	05	71	69.	60	20			4		22	3		28	3	014	2.1	1.8	2	6	8
31	NW	70-59.	158-11.	268	08	05	71	09.0	61	25			5	2		0		28	3	014	2.0	1.7	2	6	8
31	NW	71-03.	158-04.	268	08	05	71	10.1	62	32			5	7		0					.	.			
31	NW	71-04.	158-02.	268	08	05	71	11.5	63	31			5	7		0					.	.			
31	NW	71-09.	157-55.	268	08	05	71	12.5	64	43			5	5		0		28	4	014	2.4	2.0	2	6	8
31	NW	71-19.	157-54.5	268	08	05	71	14.1	65	115	06	276	4	2		0		27	2	014	.	.	4	3	9
31	NW	71-19.	157-54.5	268	08	05	71	14.1	65	115	06	276	4	2		0		27	2	014	.	.	4	3	9

MIZPAC 71 STATION HEADINGS

NAT	SHIP	LAT	LONG	MSQ	MO	DY	YR	HR	STA	DPTH	SDPTH	OBS	COD	IC	WVD	HT	PER	WND	V	BAR	DRY	WET	WTHR	CL	AMT
31	NW	71-21.	157-45.	268	08	05	71	15.4	66	122	13	252	4	5		0		27	2	014	.	.	4		9
31	NW	71-21.	157-45.	268	08	05	71	15.4	66	122	13	252	4	5		0		27	2	014	.	.	4		9
31	NW	71-21.	158-08.	268	08	05	71	19.5	68	114	15	281	2	2		0					.	.	2	5	8
31	NW	71-21.	158-08.	268	08	05	71	22.2	69	117	10	282	2	2		0		25	4	014	0.6	0.1	1	0	4
31	NW	71-17.9	157-05.5	268	08	06	71	01.0	70		11	142	4	2		0		26	3	015	.	.	1	5	4
31	NW	71-19.3	156-58.4	268	08	06	71	03.0	71	60	13	139	4	2		0		27	2	013	.	.	1	5	7
31	NW	71-19.9	156-51.1	268	08	06	71	11.2	72	43			5	4		0		25	3	010	-0.9	-0.9	6		
31	NW	71-29.	156-16.	268	08	06	71	17.2	73	134			5	4		0		29	4	018	-0.9	-0.9	4	6	8
31	NW	71-31.	155-51.	268	08	06	71	19.0	74	119	14	267	4	4		0		29	3	008	-1.5	-1.5	4	7	6
31	NW	71-25.6	155-42.	268	08	07	71	03.2	75	13			5	7		0				008	.	.	4	X	9
31	NW	71-26.8	155-41.1	268	08	07	71	04.0	76	27			5	3		0				008	.	.			
31	NW	71-26.	155-10.	268	08	07	71	07.0	78	23			5	1		0		27	2	008	.	-2.2	2		7
31	NW	71-26.	154-52.	268	08	07	71	08.0	79	18			5							008	.	.			
31	NW	71-26.2	154-52.	268	08	07	71	09.2	80	29			5	7		0		28	2	008	.	.	2	8	8
31	NW	71-22.6	154-45.	268	08	07	71	10.1	81	25			5			0				008	.	.			
31	NW	71-19.3	154-40.	268	08	07	71	11.1	82	16			5			0				008	.	.			
31	NW	71-22.	154-33.	268	08	07	71	12.1	83	27	00	10	5	2		0		32	1	008	-0.6	-0.6	7	3	5
31	NW	71-23.6	154-28.	268	08	07	71	13.2	84	29	00	10	5	2		0		33	2	008	.	.	7	7	7
31	NW	71-26.	154-23.	268	08	07	71	14.7	85	27	00	09	5	2		0		32	1		0.5	0.5	1	7	6
31	NW	71-29.	154-12.	268	08	07	71	15.9	86		00	09	5	4		0		32	2		.	.	7	7	6

MIZPAC 71 STATION HEADINGS

NAT	SHIP	LAT	LONG	MSQ	MO	DY	YR	HR	STA	DPTH	SDPTH	OBS	COD	IC	WVD	HT	PER	WND	V	BAR	DRY	WET	WTHR	CL	AMT
31	NW	71-35.	153-58.	268	08	07	71	17.9	87	58	00	11	5	1		0		30	2		.	.	7		8
31	NW	71-35.	155-47.	268	08	07	71	19.9	88	44	00	11	5			0		30	3		.	.			
31	NW	71-40.2	155-29.	268	08	08	71	11.1	89	155	00	14	5	6		0			0	014	-1.5	-1.5	4		
31	NW	71-47.	155-41.	268	08	08	71	13.8	90	139	00	15	5	3		0			0	014	-1.5	-1.7	4	5	4
31	NW	71-52.	155-58.	268	08	08	71	14.8	91	104	00	14	5	3		0		32	3	014	-2.0	-1.9	7		
31	NW	71-42.	155-36.	268	08	08	71	19.4	92	80	00	262	6	2		0		27	2	012	1.0	0.0	7	5	5
31	NW	71-46.2	155-40.8	268	08	08	71	21.7	93	89	00	255	6	2		0		30	2	012	0.8	0.0	7	6	8
31	NW	71-45.5	155-45.6	268	08	08	71	23.4	94	81	00	254	6	2		0		26	2	013	-1.8	-1.8	8	2	8
31	NW	71-47.5	155-58.	268	08	09	71	01.6	95	104	00	252	6	2		0			0	013	-1.0	.	7	7	2
31	NW	71-42.	155-47.	268	08	09	71	04.2	96	137	00	252	6	2		0	0		0	013	-1.0	.	7	7	3
31	NW	71-41.	155-56.	268	08	09	71	06.0	97	110	00	255	6	4		0			0		-1.5	.	7	X	9
31	NW	71-42.	156-17.	268	08	09	71	08.2	98	91	00	232	4	4		0	0		0	013	-2.6	-2.6	7	8	8
31	NW	71-42.	156-17.	268	08	09	71	08.2	98	91	00	232	4	4		0	0		0	013	-2.6	-2.6	7	8	8
31	NW	71-38.	156-28.	268	08	09	71	10.1	99	91	00	239	6	4		0	0		0	014	-2.9	-2.9		6	8
31	NW	71-32.8	156-15.	268	08	09	71	12.1	100	165	00	315	4	4		0			0	014	-3.1	-3.1	4	X	9
31	NW	71-32.8	156-15.	268	08	09	71	12.1	100	165	00	315	4	4		0			0	014	-3.1	-3.1	4	X	9
31	NW	71-34.	155-54.	268	08	09	71	14.1	101	168	00	317	6	7		0	0		0	014	-1.0	.	4	X	9
31	NW	71-33.	155-28.	268	08	09	71	16.0	102	168	00	321	6	7		0			0	015	-2.0	.	4	X	9
31	NW	71-34.	155-33.	268	08	09	71	18.0	103	46	00	129	6	6		0		20	1	015	-0.[illegible]	-0.8	4	X	9
31	NW	71-31.	155-04.	268	08	09	71	20.0	104	27	00	126	5	5		0		20	2	015	-0.8	-0.8	4	X	9

MIZPAC 71 STATION READINGS

NAT	SHIP	LAT	LONG	MSQ	MO	DY	YR	HR	STA	DPTH	SDPTH	CBS	CCD	IC	WVD	HT	PER	WND	V	BAR	DRY	WET	WTHR	CL	AMT
31	NW	- .	- .		08	09	71	23.2	105	43	00		6	3		0					.	.	4	X	9
31	NW	71-18.5	153-21.	268	08	10	71	05.2	106	40	00	126	6	3		0					.	.	4		
31	NW	71-13.1	153-48.	268	08	10	71	19.1	107	22	00	69	6	1		0		31	3	026	0.2	0.2		5	8
31	NW	71-10.	153-44.	268	08	11	71	06.8	108	20	00	58	6	1		0		32	2	026	0.2	0.0	2	2	8
31	NW	71-19.	153-52.	268	08	11	71	17.4	109	41	00	116	6	3		0	0		0	028	1.2	-0.2	1	6	7
31	NW	71-19.6	153-41.6	268	08	11	71	18.5	110	40	00	109	6	4		0	0		0	027	.	-0.1	2	6	8
31	NW	71-21.8	153-42.	268	08	11	71	19.4	111	47	00	126	6	4		0			0	027	.	-0.1	1	5	6
31	NW	71-21.	153-29.	268	08	11	71	20.7	112	50	00	132	6	6		0	0		0	027	.	0.0	1	5	3
31	NW	71-18.1	153-24.	268	08	11	71	21.6	113	50	00	142	6	6		0	0		0	027	.	0.0	1	5	2
31	NW	71-16.	153-10.5	268	08	11	71	22.6	114	47	00	112	6	6		0			0	027	.	0.0	1	5	2
31	NW	71-15.5	153-00.	268	08	11	71	23.7	115	34	00	92	6	4		0		10	2	026	2.8	1.9	1	5	4
31	NW	71-15.6	152-43.	268	08	12	71	00.6	116	32	00	94	6	4		0		10	2	026	2.8	1.9	1	5	4
31	NW	71-15.5	152-32.	268	08	12	71	01.6	117	29	00	86	6	3		0		10	3	026	2.4	.	1	5	2
31	NW	71-12.5	152-24.	268	08	12	71	02.6	118	32	00	92	6	2		0		10	3	025	3.6	.	1	5	1
31	NW	71-02.	152-33.	268	08	12	71	17.9	119	13	00	42	6	3		0		09	2	020	0.6	0.1	1	2	8
31	NW	70-41.5	151-10.	268	08	12	71	22.6	120	14	00	39	6	3		0		09	2	019	1.3	0.9	2	2	8
31	NW	70-42.1	150-55.	268	08	13	71	00.2	121	13	00	32		1		0		09	3	019	0.1	0.0	2	2	8
31	NW	70-46.	151-00.	268	08	13	71	01.7	122	18	00	47	6	7		0			3	019	.	-0.6	4	X	9
31	NW	70-47.9	151-10.	268	08	13	71	03.1	123	18	00	45	6	5		0			0	019	-0.2	-0.3	4	X	9
31	NW	70-52.	151-15.	268	08	13	71	04.0	124	18	00	46	6	1		0			0	019	.	.	4	7	7

MIZPAC 71 STATICN HEADINGS

NAT	SHIP	LAT	LONG	MSQ	MO	DY	YR	HR	STA	DPTH	SDPTH	OBS	COD	IC	WVD	HT	PER	WND	V	BAR	DRY	WET	WTHR	CL	AMT
31	NW	7C-56.	151-23.	268	08	13	71	04.8	125	14	00	5C	6	1		0			2	020	.	-0.2	1	6	7
31	NW	7C-55.5	151-33.	268	08	13	71	05.5	126	19	00	51	6	1		0		31	2	02C	1.0	C.7	1	5	6
31	NW	71-04.	151-52.	268	08	13	71	06.7	127	2C	00	5C	6	1		C		31	2	019	1.0	C.7	1	5	6
31	NW	71-07.	152-0C.5	268	08	13	71	C8.0	128	19	00	51	6	1		0		32	2	019	.	-0.1	1	5	5
31	NW	71-C8.8	152-C1.	268	08	13	71	17.2	129	29	00	77	6	1		0		22	2	020	.	C.C	2	5	8
31	NW	71-20.3	156-54.6	268	08	17	71	22.5	130	38	00	117	6	1		1		36	4	002	.	.	2	5	8
31	NW	71-35.	158-15.	268	08	18	71	02.1	131	72	00	191	6	4		0		35	3	004	.	.	2	5	8
31	NW	71-35.	158-14.	268	08	18	71	03.0	132	172	00	189	6	4		0		35	3	0C4	.	-C.2	2	5	8
31	NW	71-37.	158-15.	268	08	18	71	04.3	133	7C	00	17C	6	4		0		35	2	004	0.0	-0.1	2	1	8
31	NW	71-43.	158-45.	268	08	18	71	12.2	134	61		168	6	7		0		32	1	005	-2.0	-2.C	2	7	8
31	NW	71-43.	158-45.	268	08	18	71	13.2	135	61	06	153	1	7		C					.	.	2	7	8
31	NW	71-43.	158-45.	268	08	18	71	14.4	136S	6C	12	45	3	6		0		35	3	005	.	-1.6	4	X	9
31	NW	71-43.	158-45.	268	08	18	71	14.4	136D	60	12	167	3	6		0		35	3	005	.	-1.6	4	X	9
31	NW	71-43.	158-45.	268	08	18	71	15.3	137S	6C	17	47	3	6		0				005	.	-1.6	7	X	9
31	NW	71-43.	158-45.	268	08	18	71	15.3	137D	60	17	158	3	6		0				005	.	-1.6	7	X	9
31	NW	71-44.	158-38.	266	08	18	71	16.4	138S	6C	11	64	3	6		0		34	1	005	.	-1.4	7	7	8
31	NW	71-44.	158-38.	268	08	18	71	16.4	138D	6C	11	158	3	6		0		34	1	005	.	-1.4	7	7	8
31	NW	71-38.	158-5C.5	268	08	18	71	18.4	139S		13	45	3	6		0					.	.			
31	NW	71-38.	158-50.5	268	08	18	71	18.4	139D		13	158	3	6		0					.	.			
31	NW	71-36.	158-45.	268	08	18	71	21.5	140S		12	37	3	8		0		33	2	006	.	.	2	7	8

MIZPAC 71 STATION READINGS

NAT	SHIP	LAT	LONG	MSQ	MO	DY	YR	HR	STA	DPTH	SDPTH	CBS	COD	IC	WVD	HT	PER	WND	V	BAR	DRY	WET	WTHR	CL	AMT
31	NW	71-36.	158-45.	268	08	18	71	21.5	140D		12	158	3	8		0		33	2	006	.	.	2	7	8
31	NW	71-36.	158-45.	268	08	19	71	00.0	141S	52	12	45	3	6		0		34	1	006	0.1	-0.1	2	2	8
31	NW	71-36.	158-45.	268	08	19	71	00.0	141D	52	12	157	3	6		0		34	1	006	0.1	-0.1	2	2	8
31	NW	71-32.5	158-39.	268	08	19	71	03.5	142S	51	12	61	3	4		0		32	2	005	.	-0.5	2	5	8
31	NW	71-32.5	158-39.	268	08	19	71	03.5	142D	51	12	145	3	4		0		32	2	005	.	-0.5	2	5	8
31	NW	71-21.8	158-33.3	268	08	19	71	04.5	143S	62	13	64	3	4		0		32	2		-0.2	-0.6	2	7	8
31	NW	71-21.8	158-33.3	268	08	19	71	04.5	143D	62	13	158	3	4		0		32	2		-0.2	-0.6	2	7	8
31	NW	71-22.2	158-38.	268	08	19	71	05.7	144S	68	18	60	3	4		0		32	2	005	-0.2	-0.2	2	7	8
31	NW	71-22.2	158-38.	268	08	19	71	05.7	144D	68	18	159	3	4		0		32	2	005	-0.2	-0.2	2	7	8
31	NW	71-18.5	158-40.	268	08	19	71	06.6	145S	101	19	63	3	3		0					.	.	2	6	8
31	NW	71-18.5	158-40.	268	08	19	71	06.6	145D	101	19	194	3	3		0					.	.	2	6	8
31	NW	71-16.5	158-38.	268	08	19	71	07.4	146S	124	16	80	3								.	.	2		
31	NW	71-16.5	158-38.	268	08	19	71	07.4	146D	124	16	237	3								.	.	2		
31	NW	71-14.	158-38.	268	08	19	71	08.1	147S	121	16	79	3	3		0					.	.	2	5	8
31	NW	71-14.	158-38.	268	08	19	71	08.1	147D	121	16	236	3	3		0					.	.	2	5	8
31	NW	71-14.7	158-52.	268	08	19	71	08.8	148S	110	16	82	3	2		0				004	.	.	7	X	9
31	NW	71-14.7	158-52.	268	08	19	71	08.8	148D	110	16	237	3	2		0				004	.	.	7	X	9
31	NW	71-13.	158-52.	268	08	19	71	09.6	149S	93	10	79	3	1		0		02	2	005	.	.	7	X	9
31	NW	71-13.	158-52.	268	08	19	71	09.6	149D	93	10	237	3	1		0		02	2	005	.	.	7	X	9
31	NW	71-06.	159-00.	268	08	19	71	10.6	150S	112	10	61	3	2		1		02	2	004	0.5	.	7	X	9

MIZPAC 71 STATION HEADINGS

NAT	SHIP	LAT	LONG	MSQ	MO	DY	YR	HR	STA	DPTH	SDPTH	OBS	COD	IC	WVD	HT	PER	WND	V	BAR	DRY	WET	WTHR	CL	AMT
31	NW	71-06.	159-00.	268	08	19	71	10.6	150D	112	10	238	3	2		1		02	2	004	0.5	.	7	X	9
31	NW	71-07.	159-14.	268	08	19	71	11.5	151S	112	14	65	3	1		1		01	4	005	1.0	.	5		
31	NW	71-07.	159-14.	268	08	19	71	11.5	151D	112	14	237	3	1		1		01	4	005	1.0	.	5		
31	NW	71-08.	159-24.	268	08	19	71	12.6	152S		14	60	3	4		0		00	4	004	.	-0.8	7	X	9
31	NW	71-08.	159-24.	268	08	19	71	12.6	152D		14	236	3	4		0		00	4	004	.	-0.8	7	X	9
31	NW	71-09.	159-27.5	268	08	19	71	13.5	153S	71	13	66	3	1		0		00	3	005	.	-0.6	2	7	8
31	NW	71-09.	159-27.5	268	08	19	71	13.5	153D	71	13	158	3	1		0		00	3	005	.	-0.6	2	7	8
31	NW	71-07.	159-41.	268	08	19	71	14.5	154D	75	10	209	2	1		0		00	3	005	-0.7	-0.7	2	7	8
31	NW	71-13.	159-34.	268	08	19	71	16.2	155S	69	13	65	3	1		0		01	5	005	-0.7	-0.7	2	2	8
31	NW	71-13.	159-34.	268	08	19	71	16.2	155D	69	13	65	3	1		0		01	5	005	-0.7	-0.7	2	2	8
31	NW	71-17.	159-25.	268	08	19	71	17.5	156S	55	18	80	3	4		0		00	4	005	-0.5	-0.5	7	7	8
31	NW	71-17.	159-25.	268	08	19	71	17.5	156D	55	18	157	3	4		0		00	4	005	-0.5	-0.5	7	7	8
31	NW	71-23.8	159-19.5	268	08	19	71	19.0	157S	49	14	58	3	6		0		00	5	005	-0.5	-0.5	7	7	8
31	NW	71-23.8	159-19.5	268	08	19	71	19.0	157D	49	14	142	3	6		0		00	5	005	-0.5	-0.5	7	7	8
31	NW	71-26.5	159-11.0	268	08	19	71	22.8	159S	46	10	57	3	7		0		34	5	006	-1.1	-1.9	2	7	8
31	NW	71-26.5	159-11.0	268	08	19	71	22.8	159D	46	10	126	3	7		0		34	5	006	-1.1	-1.9	2	7	8
31	NW	71-30.5	158-40.	268	08	20	71	08.5	160	46	00	127	1			0		35	4	007	.	.	2	7	8
31	NW	71-29.	158-37.	268	08	20	71	09.8	161	49	00	127	1	2		0		35	2	007	1.0	.	2	7	8
31	NW	71-23.	158-27.	268	08	20	71	10.6	162S	128	14	59	3							007	.	.	2		
31	NW	71-23.	158-27.	268	08	20	71	10.6	162D	128	14	222	3							007	.	.	2		

MIZPAC 71 STATION HEADINGS

NAT	SHIP	LAT	LONG	MSQ	MO	DY	YR	HP	STA	DPTH	SDPTH	OBS	CCD	IC	WVD	HT	PER	WND	V	BAR	DRY	WET	WTHR	CL	AMT
31	NW	71-12.	158-48.	268	08	20	71	17.0	163S	123	15	78	3	1		C		02	4	009	-0.8	.	7	5	8
31	NW	71-12.	158-48.	268	08	20	71	17.0	163D	123	15	285	3	1		0		02	4	009	-0.8	.	7	5	8

MIZPAC 72 STATION READINGS

NAT	SHIP	LAT	LONG	MSQ	MO	DY	YR	HR	STA	DPTH	SDPTH	CBS	CCD	IC	WVD	HT	PER	WND	V	BAR	DRY	WET	WTHR	CL	AMT
31	BI	71-53.	160-16.	269	07	28	72	20.2	001S	0035	00		1	08							.	.			
31	BI	71-53.	160-16.	269	07	28	72	20.2	001D	0035	00		1	08							.	.			
31	BI	71-41.	160-19.	269	07	29	72	01.8	003S	0017	00		9								.	.			
31	BI	71-41.	160-19.	269	07	29	72	01.8	003D	0017	05		9								.	.			
31	BI	71-38.	160-19.	269	07	29	72	02.8	004	0048	01		2	1	00	0					.	.			
31	BI	71-34.	160-23.	269	07	29	72	03.8	005	0048	00		1	0	00	0			1		.	-0.2			
31	BI	71-28.5	160-26.5	269	07	29	72	04.8	006	0046	00		1	00		2		05	3		.	01.2			
31	BI	71-28.9	160-36.5	269	07	29	72	06.7	007	0046	03		2	00		2					.	-0.1			
31	BI	71-28.	160-16.	269	07	29	72	17.1	008S	0041	00		3								.	.			
31	BI	71-28.	160-16.	269	07	29	72	17.1	008D	0041	08		3								.	.			
31	BI	71-23.	158-41.	268	07	29	72	22.1	009	0053	10		2	00		2					.	.			
31	BI	71-24.5	159-33.	268	07	30	72	00.8	010S	0038	00		3	00				06	4		.	.			
31	BI	71-24.5	159-33.	268	07	30	72	00.8	010D	0038	10		3	00				06	4		.	.			
31	BI	71-27.	161-08.	269	07	30	72	11.1	011S		00		3	07	00	0			3		.	.			
31	BI	71-27.	161-08.	269	07	30	72	11.1	011D		02		3	07	00	0			3		.	.			
31	BI	71-27.	161-08.	269	07	30	72	23.2	012S	0044	00		3	07	00	0		07	3		.	03.9			
31	BI	71-27.	161-08.	269	07	30	72	22.9	012D	0044	05		3	07	00	0		07	3		.	03.9			
31	BI	71-18.	160-46.	269	07	31	72	15.5	013	0044	05		2	06					1		.	.			
31	BI	71-17.	160-50.	269	07	31	72	16.8	014S	0044	00		3	01					2		.	.			
31	BI	71-17.	160-50.	269	07	31	72	16.8	014D	0044	04		3	01					2		.	.			

MIZPAC 72 STATION READINGS

NAT	SHIP	LAT	LONG	MSQ	MO	DY	YR	HR	STA	DPTH	SDPTH	OBS	CCD	IC	WVD	HT	PER	WND	V	BAR	DRY	WET	WTHR	CL	AMT
31	BI	71-16.	160-49.	269	07	31	72	17.4	015S	0046	00		3	00				15			.	.			
31	BI	71-16.	160-49.	269	07	31	72	17.4	015D	0046	06		3	00				15	2		.	.			
31	BI	71-13.5	160-51.	269	07	31	72	17.9	016S	0051	00		3	00		0		21	3		.	.			
31	BI	71-13.5	160-51.	269	07	31	72	17.9	016D	0051	09		3	00		0		21	3		.	.			
31	BI	71-11.	160-50.	269	07	31	72	18.6	017S	0051	00		1	00				19	1		.	.			
31	BI	71-11.	160-50.	269	07	31	72	18.6	017D	0051	00		1	00				19	1		.	.			
31	BI	71-06.8	160-49.0	269	07	31	72	19.4	018S	0054	00		3	00				19	3		.	.			
31	BI	71-06.8	160-49.0	269	07	31	72	19.4	018D	0054	04		3	00				19	3		.	.			
31	BI	70-43.	160-16.	269	08	01	72	00.6	019	0024	00		1					24			.	.			
31	BI	70-51.	161-14.	269	08	01	72	03.2	020S	0049	00		1	00				27	2		.	.			
31	BI	70-51.	161-14.	269	08	01	72	03.2	020D	0049	00		1	00				27	2		.	.			
31	BI	71-06.	162-06.	269	08	01	72	06.1	021S	0051	00		1	00				21	2		.	.			
31	BI	71-06.	162-06.	269	08	01	72	06.1	021D	0051	00		1	00				21	2		.	.			
31	BI	71-09.5	162-26.	269	08	01	72	08.2	022	0050	00		1	00				20	3		.	.			
31	BI	71-15.	162-26.	269	08	01	72	09.3	023	0048	00		1	00				20	4		.	.			
31	BI	71-17.8	162-26.	269	08	01	72	10.6	024S	0048	00		3	00				27	3		.	.			
31	BI	71-17.8	162-26.	269	08	01	72	10.2	024D	0048	05		3	00				27	3		.	.			
31	BI	71-19.8	162-26.	269	08	01	72	11.2	025S	0048	00		3	-1	18	3		20	4		.	.			
31	BI	71-19.8	162-26.	269	08	01	72	11.0	025D	0048	03		3	-1	18	3		20	4		.	.			
31	BI	71-21.	162-26.	269	08	01	72	16.7	026S	0050	00		3	-1	18	2		22	2		.	.	5		

MIZPAC 72 STATION HEADINGS

NAT	SHIP	LAT	LONG	MSQ	MO	DY	YR	HR	STA	DPTH	SDPTH	CES	CCD	IC	WVD	HT	PER	WND	V	BAR	DRY	WET	WTHR	CL	AMT
31	BI	71-21.	162-26.	269	08	01	72	16.4	026D	0050	01		3	-1	18	2		22	2		.	.	5		
31	BI	71-23.	162-26.	269	08	01	72	18.3	027S	0048	00		3	04	00	0		05	3		.	06.0		4	8
31	BI	71-23.	162-26.	269	08	01	72	18.1	027D	0048	02		3	04	00	0		05	3		.	06.0		4	8
31	BI	71-24.5	162-16.	269	08	01	72	19.7	028S	0051	00		3	06	00	0		21	2		.	04.7		6	8
31	BI	71-24.5	162-16.	269	08	01	72	19.5	028D	0051	05		3	06	00	0		21	2		.	04.7		6	8
31	BI	71-34.	161-58.	269	08	02	72	00.7	029	0044	01		2	08	00	0		16	1		.	06.8	4	3	7
31	BI	71-29.	161-58.	269	08	02	72	05.8	030	0048	01		2	07	00	0		09	3		.	05.5	0		0
31	BI	71-09.	162-10.	269	08	02	72	19.1	031	0048	00		1	00		2		13	1		.	06.8	0		0
31	BI	71-06.	162-59.	269	08	02	72	21.2	032S	0045	00		3	00				08	3		.	.			
31	BI	71-06.	162-59.	269	08	02	72	21.2	032D	0045	07		3	00				08	3		.	.			
31	BI	71-07.	163-06.	269	08	02	72	22.3	033S	0046	00		3	03				11	2		.	.			
31	BI	71-07.	163-06.	269	08	02	72	22.3	033D	0046	08		3	03				11	2		.	.			
31	BI	71-06.	166-16.	269	08	03	72	05.1	034	0052	00		1	00		2		04	2		.	.	0		0
31	BI	71-07.8	166-28.5	269	08	03	72	07.3	035	0044	00		1	00				28	1		.	.			
31	BI	71-25.	167-00.	269	08	03	72	09.2	036	0048	00		1	00				26	3		.	.			
31	BI	71-35.5	166-59.5	269	08	03	72	10.6	037	0048	00		1	00				33	2		.	.			
31	BI	71-48.3	166-56.4	269	08	03	72	11.8	038	0048	00		7	00	00	0		09	1		.	07.9	0		0
31	BI	71-55.	166-51.	269	08	03	72	12.5	039	0048	00		1	00	00	0			1		.	06.4	0		0
31	BI	72-00.	166-46.	269	08	03	72	13.0	040	0049	01		2	00	00	0		24	1		.	.			
31	BI	72-14.	166-50.	269	08	03	72	14.8	041S	0049	00		3	00				33	2		.	.			

MIZPAC 72 STATION READINGS

NAT	SHIP	LAT	LONG	MSQ	MO	DY	YR	HR	STA	DPTH	SDPTH	CBS	CCD	IC	WVD	HT	PER	WND	V	BAR	DRY	WET	WTHR	CL	AMT
31	BI	72-14.	166-50.	269	08	03	72	14.5	041D	0049	05		3	00				33	2		.	.			
31	BI	72-19.	166-47.	269	08	03	72	15.8	042S	0049	00		3	00	00	0		24	1		.	04.2		6	1
31	BI	72-19.	166-47.	269	08	03	72	15.8	042D	0049	04		3	00	00	0		24	1		.	04.2		3	1
31	BI	72-35.	166-34.	269	08	03	72	18.3	043S	0054	00		3	00	00	0		31	1		.	04.6		6	8
31	BI	72-35.	166-34.	269	08	03	72	18.3	043D	0054	06		3	00	00	0		31	1		.	04.6		6	8
31	BI	72-38.	166-41.	269	08	03	72	19.5	044S	0054	00		3	00	00	0		29	1		.	.			
31	BI	72-38.	166-41.	269	08	03	72	19.3	044D	0054	06		3	00	00	0		29	1		.	.			
31	BI	72-43.	166-08.	269	08	03	72	22.4	045S	0042	00		3	01				30	2		.	.			
31	BI	72-43.	166-08.	269	08	03	72	22.4	045D	0042	03		3	01				30	2		.	.			
31	BI	72-44.	166-06.	269	08	03	72	23.1	046S	0042	00		3	01				33	2		.	.			
31	BI	72-44.	166-06.	269	08	03	72	23.1	046D	0042	01		3	01				33	2		.	.			
31	BI	72-47.	166-06.	269	08	03	72	23.9	047	0057	00		1	05					1		.	.			
31	BI	72-55.	166-06.	269	08	04	72	01.0	048	0057	00		1	05				33	2		.	.			
31	BI	73-05.	165-57.	269	08	04	72	02.8	049	0060	00		1	07	00	0		31	1		.	.			
31	BI	73-20.	165-54.	269	08	05	72	03.5	050S	0072	00		3	07	00	0		24	3		.	00.5			
31	BI	73-20.	165-54.	269	08	05	72	03.3	050D	0072	08		3	07	00	0		24	3		.	00.5			
31	BI	72-47.	166-44.	269	08	06	72	23.0	051	0049	00		1	03	3	4		33	5		.	00.6		7	8
31	BI	72-47.	166-29.	269	08	07	72	00.0	052S	0052	00		3	03	0	4		31	5		.	01.2		6	8
31	BI	72-47.8	166-20.5	269	08	07	72	00.0	053	0056	00		1	02	5	4		33	5		.	.		6	8
31	BI	72-47.9	166-18.	269	08	07	72	01.2	054	0056	00		1	-1		4		31	4		.	00.6		6	8

MIZPAC 72 STATION READINGS

NAT	SHIP	LAT	LONG	MSQ	MO	DY	YR	HR	STA	DPTH	SDPTH	CBS	CCD	IC	WVD	HT	PER	WND	V	BAR	DRY	WET	WTHR	CL	AMT
31	BI	72-48.2	166-15.	269	08	07	72	01.8	055	0054	00		1	01		4		34	4		.	.		6	8
31	BI	72-48.8	166-11.5	269	08	07	72	02.2	056S	0056	00		3	03							.	.			
31	BI	72-49.	166-08.5	269	08	07	72	02.7	057S	0056	00		3	03				31			.	.			
31	BI	72-49.	166-08.5	269	08	07	72	02.7	057D	0056	05		3	03				31	4		.	.			
31	BI	72-49.5	165-58.0	269	08	07	72	03.6	058	0055	00		1	04				30	4		.	.			
31	BI	72-51.	165-40.	269	08	07	72	04.8	059S	0058	00		3	02				30	4		.	.			
31	BI	72-51.	165-40.	269	08	07	72	04.8	059D	0058	07		3	02				30	4		.	.			
31	BI	72-53.8	165-32.	269	08	07	72	23.6	060S	0059	04		3	06	00	0		21	4		.	00.4		7	7
31	BI	72-53.8	165-32.	269	08	07	72	23.6	060D	0059	07		3	06	00	0		21	4		.	00.4		7	7
31	BI	72-37.9	162-56.0	269	08	09	72	06.0	061	0045	00		1	01	23	4		28	5		.	02.0			
31	BI	72-35.6	162-40.	269	08	09	72	07.5	062	0042	03		2	02				30	5		.	.			
31	BI	72-35.	162-22.	269	08	09	72	08.9	063	0040	04		2	02				29	4		.	.			
31	BI	72-55.	162-03.	269	08	10	72	03.0	064S	0084	00		3	06				24	1		.	.			
31	BI	72-55.	162-03.	269	08	10	72	02.4	064D	0084	09		3	06				24	1		.	.			
31	BI	72-56.6	161-47.0	269	08	10	72	18.8	065S	0089	00		3	05	00	0		22	2		.	-0.1		6	8
31	BI	72-56.6	161-47.0	269	08	10	72	18.8	065D	0089	12		3	05	00	0		22	2		.	-0.1		6	8
31	BI	72-00.	161-44.	269	08	11	72	06.9	066	0034	00		1	00	00	0		27	4		.	02.8	1	6	1
31	BI	71-59.8	161-18.9	269	08	11	72	08.2	067	0037	00		1	00				30	4		.	02.7			7
31	BI	71-59.	160-50.	269	08	11	72	09.0	068	0039	00		1	00		3		26	4		.	02.5		7	8
31	BI	71-58.4	160-39.5	269	08	11	72	09.7	069	0048	00		1	00				28	4		.	.			

MIZPAC 72 STATION HEADINGS

NAT	SHIP	LAT	LONG	MSQ	MO	DY	YR	HR	STA	DPTH	SDPTH	OBS	CCD	IC	WVD	HT	PER	WND	V	BAR	DRY	WET	WTHR	CL	AMT
31	BI	71-58.2	160-32.	269	08	11	72	10.3	070S	0048	00		3	00				29	4		.	.			
31	BI	71-58.2	160-32.	269	08	11	72	10.1	070D	0048	01		3	00				29	4		.	.			
31	BI	71-58.1	160-28.7	269	08	11	72	10.8	071S	0039	00		3	06				31	4	4	.	.			
31	BI	71-58.1	160-28.7	269	08	11	72	10.6	071D	0039	04		3	06				31	4		.	.			
31	BI	71-58.	160-25.	269	08	11	72	11.4	072S	0051	00		3	06				28	4		.	.			
31	BI	71-58.	160-25.	269	08	11	72	11.4	072D	0051	03		3	06				28	4		.	.			
31	BI	71-58.	160-25.	269	08	11	72	12.7	073S	0037	00		3	05							.	.			
31	BI	71-58.	160-25.	269	08	11	72	12.7	073D	0037	05		3	05							.	.			
31	BI	71-58.	160-25.	269	08	11	72	13.7	074S	0039	00		3	05							.	.			
31	BI	71-58.	160-25.	269	08	11	72	13.7	074D	0039	07		3	05							.	.			
31	BI	71-58.	160-25.	269	08	11	72	14.7	075	0039	11		2	05				30	3		.	.			
31	BI	71-54.	160-00.	269	08	12	72	01.0	076S	0049	00		3	06	00	0		29	4		.	.			
31	BI	71-54.	160-00.	269	08	12	72	00.8	076D	0049	11		3	06	00	0		29	4		.	.			
31	BI	71-33.4	158-42.5	268	08	12	72	07.3	077S	0057	00		3	-4	00	0		09	4		.	-0.6	4	X	9
31	BI	71-33.4	158-42.5	268	08	12	72	07.0	077D	0057	09		3	-4	00	0		09	4		.	-0.6	4	X	9
31	BI	71-32.8	158-40.	268	08	12	72	07.9	078S	0054	00		3	-4				10	3		.	.			
31	BI	71-32.8	158-40.	268	08	12	72	07.7	078D	0054	07		3	-4				10	3		.	.			
31	BI	71-32.3	158-37.4	268	08	13	72	08.6	079S	0057	00		3	-4	00	0		09	4		.	.			
31	BI	71-32.3	158-37.4	268	08	13	72	08.3	079D	0057	12		3	-4	00	0		09	4		.	.			
31	BI	71-30.7	158-30.	268	08	13	72	09.3	080S	0057	00		3	-3	00	0		09	4		.	-0.2			

MIZPAC 72 STATION HEADINGS

NAT	SHIP	LAT	LONG	MSQ	MO	DY	YR	HR	STA	DPTH	SDPTH	CBS	CCD	IC	WVD	HT	PER	WND	V	BAR	DRY	WET	WTHR	CL	AMT
31	BI	71-30.7	158-30.	268	08	13	72	09.3	080D	0057	09		3	-3	00	0		09	4		.	-0.2			
31	BI	71-28.	158-20.	268	08	13	72	10.8	081S	0060	00		3	01	00	0		11	3		.	.			
31	BI	71-28.	158-20.	268	08	13	72	10.8	081D	0060	06		3	01	00	0		11	3		.	.			
31	BI	71-20.	156-45.	268	08	13	72	23.0	082	0030	00		1	00		3			6		.	02.5			
31	BI	71-20.	156-45.	268	08	14	72	19.6	083S	0033	00		3					08	4		.	.			
31	BI	71-20.	156-45.	268	08	14	72	19.6	083D	0033	04		3					08	4		.	.			
31	BI	71-13.	157-43.	268	08	15	72	04.2	084	0055	00		1	00				06	3		.	.			
31	BI	71-07.	158-46.	268	08	15	72	06.2	085S	0054	00		3	00				06	4		.	.			
31	BI	71-07.	158-46.	268	08	15	72	06.2	085D	0054	12		3	00				06	4		.	.			
31	BI	70-59.	159-35.6	268	08	15	72	08.3	086	0063	00		1	00				03	4		.	.			
31	BI	70-59.	160-00.	269	08	15	72	09.6	087	0056	00		1	00				03	4		.	.			
31	BI	71-01.	160-00.	269	08	15	72	10.5	088S	0067	00		3	-6		2		03	4		.	00.7	4	X	9
31	BI	71-01.	160-00.	269	08	15	72	10.2	088D	0067	08		3	-6		2		03	4		.	00.7	4	X	9
31	BI	71-02.	160-00.	269	08	15	72	10.9	089S	0072	00		3	-5		2		05	5		.	.	4	X	9
31	BI	71-02.	160-00.	269	08	15	72	10.9	089D	0072	08		3	-5		2		05	5		.	.	4	X	9
31	BI	71-03.	160-00.	269	08	15	72	11.7	090D	0070	10		3	01	00	0		09	5		.	00.4	4	X	9
31	BI	71-03.	160-00.	269	08	15	72	12.0	090S	0070	00		3	01	00	0		09	5		.	00.4	4	X	9
31	BI	71-04.	160-16.	269	08	15	72	13.2	091S	0059	03		3	05	00	0		06	3		.	.	4	X	9
31	BI	71-04.	160-16.	269	08	15	72	13.2	091D	0059	05		3	05	00	0		06	3		.	.	4	X	9
31	BI	71-05.	160-59.	269	08	15	72	17.2	092S	0048	00		3	-2				05	2		.	.			

MIZPAC 72 STATION READINGS

NAT	SHIP	LAT	LONG	MSQ	MO	DY	YR	HR	STA	DPTH	SDPTH	CBS	CCD	IC	WVD	HT	PER	WND	V	BAR	DRY	WET	WTHR	CL	AMT
31	BI	71-05.	160-59.	269	08	15	72	17.0	092D	0048	04		3	-2				05	2		.	.			
31	BI	71-16.	161-48.	269	08	15	72	19.1	093	0051	00		1	00				08	4		.	.			
31	BI	71-28.	162-48.	269	08	15	72	21.2	094	0042	00		1	00				05	3		.	.			
31	BI	71-38.	163-44.	269	08	15	72	23.0	095	0042	00		1	-4		3		03	4		.	.			
31	BI	71-36.5	164-47.2	269	08	16	72	00.7	096	0039	00		1	00				03	3		.	.			
31	BI	72-29.	165-18.	269	08	16	72	06.7	097	0049	00		1	00	00	0		01	1		.	00.4			
31	BI	72-36.8	165-17.8	269	08	16	72	07.3	098S	0049	00		3	00	00	0		05	1		.	.			
31	BI	72-36.8	165-17.8	269	08	16	72	07.3	098D	0049	03		3	00	00	0		05	1		.	.			
31	BI	72-39.	165-14.	269	08	16	72	08.0	099S	0056	00		3	01				06	1		.	-0.3			
31	BI	72-39.	165-14.	269	08	16	72	08.0	099D	0056	02		3	01				06	1		.	-0.3			
31	BI	72-41.5	165-08.	269	08	16	72	18.8	100S	0054	00		3	01	00	0		33	2		.	00.8		6	6
31	BI	72-41.5	165-06.	269	08	16	72	18.5	100D	0054	03		3	01	00	0		33	2		.	00.8		6	6
31	BI	72-42.8	165-05.	269	08	16	72	20.0	101S	0058	00		3	01	00	0		34	2		.	.		6	6
31	BI	72-42.8	165-05.	269	08	16	72	19.7	101D	0058	04		3	01	00	0		34	2		.	.		6	6
31	BI	72-44.8	164-59.2	269	08	16	72	21.0	102S	0058	00		3	02	00	0		30	1		.	01.3			
31	BI	72-44.8	164-59.2	269	08	16	72	20.6	102D	0058	07		3	02	00	0		30	1		.	01.3			
31	BI	73-20.	165-23.	269	08	17	72	19.9	103S	0074	00		3	06	00	0		10	5		-1.0	.			
31	BI	73-20.	165-23.	269	08	17	72	19.6	103D	0074	10		3	06	00	0		10	5		-1.0	.			
31	BI	72-45.	164-27.	269	08	18	72	01.7	104S	0057	00		3	02	00	0		10	5		.	.			
31	BI	72-45.	164-27.	269	08	18	72	01.4	104D	0057	06		3	02	00	0		10	5		.	.			

MIZPAC 72 STATION READINGS

NAT	SHIP	LAT	LONG	MSQ	MO	DY	YR	HR	STA	DPTH	SDPTH	OBS	CCD	IC	WVD	HT	PER	WND	V	BAR	DRY	WET	WTHR	CL	AMT
31	BI	71-25.	157-27.	268	08	18	72	19.3	1059	0116	00		3	00		3		11	6		.	03.5		7	8
31	BI	71-25.	157-27.	268	08	18	72	19.0	105D	0116	08		3	00		3		11	6		.	03.5		7	8
31	BI	71-20.4	157-27.7	268	08	18	72	19.9	106	0099	00		1	00	11	3		11	6		.	.		6	8
31	BI	71-30.	157-23.	268	08	18	72	21.0	1079	0107	00		3	-1				10	6		.	.			
31	BI	71-30.	157-23.	268	08	18	72	21.0	107D	0107	05		3	-1				10	6		.	.			
31	BI	71-35.	157-23.	268	08	18	72	21.9	1089	0080	00		3	00				09	6		.	.			
31	BI	71-35.	157-23.	268	08	18	72	21.9	108D	0080	06		3	00				09	6		.	.			
31	BI	71-46.	157-30.	268	08	18	72	23.5	1099	0072	00		3	00		3		10	6		03.7	.		7	8
31	BI	71-46.	157-30.	268	08	18	72	23.1	109D	0072	06		3	00		3		10	6		03.7	.		7	8
31	BI	71-56.	157-32.	268	08	19	72	01.0	1109	0073	00		3			3		09	6		.	.			
31	BI	71-56.	157-32.	268	08	19	72	00.8	110D	0073	11		3			3		09	6		.	.			
31	BI	72-00.	157-32.	268	08	18	72	01.8	1119	0078	00		3	02	00	0		09	6		.	.			
31	BI	72-00.	157-32.	268	08	18	72	01.5	111D	0078	09		3	02	00	0		09	6		.	.			
31	BI	72-03.	157-32.	268	08	19	72	02.4	1129	0100	00		3	04	00	0		09	7		.	.			
31	BI	72-03.	157-32.	268	08	19	72	02.4	112D	0100	05		3	04	00	0		09	7		.	.			
31	BI	72-07.7	157-41.1	268	08	19	72	04.9	1139	0066	00		3	01		2		09	7		.	.	6	7	8
31	BI	72-07.7	157-41.1	268	08	19	72	04.7	113D	0066	05		3	01		2		09	7		.	.	6	7	8
31	BI	72-21.4	158-03.5	268	08	19	72	20.5	1149	0071	08		3	01	00	0		12	3		.	03.2		7	4
31	BI	72-21.4	158-03.5	268	08	19	72	20.3	114D	0071	15		3	01	00	0		12	3		.	03.2		7	4

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Temperature and salinity measurements were made in and near the ice in the Chukchi and Beaufort Seas with a continuously profiling instrument in August of 1971 and 1972 as part of the MIZPAC Program. Warm water of Bering Sea origin was found south of the ice in all of the area surveyed, layered sharply on top of cold water. Complex temperature and sound-velocity profiles were found near the Alaskan Coast north of the ice margin, diminishing in intensity toward the interior of the ice pack but still noticeable (continued on back)

20. ABSTRACT (continued)

30 miles inside the ice boundary. West of the coastal zone, to 167° W, the phenomena were much milder and more quickly damped by the ice. The coastal current was observed to turn, perhaps branch, and flow along the Beaufort Sea slope, below the surface at a depth of 25-50 m, to a longitude of 152°W. Other information indicates that it maintains its identity for at least another 100 miles eastward.